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BAYER LEVERKUSEN (GERMANY)
Department for Plant Protection

# Systemic Preparations against Pests Occurring on Fruit Trees, Berries and Ornamental Plants

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## Introduction

Systemic preparations are absorbed by leaves, shoot axes and roots and are translocated together with the sap stream so that the untreated plant parts are also rendered toxic to certain sucking pest species. The eradication of pests with the older types of insecticides is effected either by the insects being directly hit by the spray wash or by coming into contact with the deposit of spray present on the leaves. Moreover these contact poisons also act as stomach poisons when the pests consume plant parts coated with toxic substance. Many preparations also have a certain vapour action. The thiophosphorus preparations, which are absorbed through the various parts of the plant, are contact poisons bordering on systemic preparations.

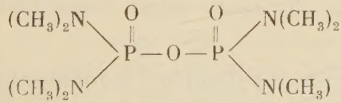
It has so far been established that selenium compounds, organic fluorine compounds and organic phosphorus compounds have a systemic effect (cf. "Systemic Preparations", Gartneryrket No. 47, 1950). Of these groups, the greatest interest is provided by the organic phosphorus compounds.

From 1950 to 1952 the following systemic preparations were tested by Statens Plantevern, Zoological Department: bis(isopropylamido)fluorophosphate, three "Schradan" preparations and "Systox".

## "Schradan" Preparations

These preparations all contain the same active ingredient, namely octamethyl pyrophosphoric amide which has been given the group designation "Schradan" after the name of the discoverer G. Schrader. In the U.S.A. the group designation "Ompa" is also used.

The structural formula of "Schradan" is as follows (Schrader's code number 13/163):



It is a colourless liquid which mixes readily with water and hydrolyzes quickly in acid solutions although not so rapidly in neutral and alkaline solutions.

"Schradan 3" contains 66 % octamethyl pyrophosphoramide ("Ompa") plus phosphorus-containing pentadimethylamide. The effect against pests is solely systemic. What vapour or contact action it has is very slight to zero, which

implies that it is harmless to useful predators and parasites (selective). "Schradan 3" is absorbed slowly by the plants so that it does not become effective until after 2 to 4 days. In the greenhouse the effect is produced much more quickly. When a standard solution concentration of 0·1 % is used, the preparation should remain effective for 3 to 5 weeks. When the sprinkling method is employed, which is only of interest for greenhouses, the preparation does not take effect so quickly as when it is sprayed, but this is made up for by the fact that it remains effective for a longer period. Ripper et al. (1951) have stated that cases have been discovered where new shoots containing "Schradan" have appeared 70 days after the application of the preparation by sprinkling.

"Schradan 3" is gradually decomposed into other compounds in the plants. The rate at which this takes place depends upon several factors: the season, the plant species, age and growing power of the plant, temperature and humidity etc. According to Heath et al. (1952), the substance disappears more rapidly in May and June than at any other time. Experiments with radioactive-labelled phosphorus have shown that approximately 90 % disappears in 40 days. This process would take several months before it is completed when treatments are carried out in Autumn. Exudation through the leaves in the form of vapour, as the result of guttation or through the roots, is of minor significance. Exudation by guttation varies according to the plant species. For example, in the case of strawberry plants this process of exudation can lead to a speedier reduction of the concentration than the usual transformation in the plants (Heath). Normally, one must allow for a period of 6 to 7 weeks to elapse between the last application and the harvest when treatments are carried out in Summer.

An effect is obtained particularly against mites and aphids (not against the eggs). With high concentrations, it has been ascertained that it is also effective to a certain degree against other pests. This, however, is of no practical significance. The best effect is produced in Spring and early Summer. In the case of later treatments the effect is not so great, partly due to the fact that the plants no longer grow so vigorously.

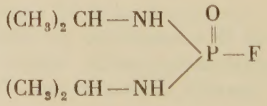
"Schradan 3" is miscible with the usual types of insecticides and fungicides, with the exception of lime sulphur and Bordeaux mixtures.

"Schradan 2" contains 70 % of the same active ingredient also contained in "Schradan 3". With one exception, it also has the same properties, this exception being that according to the manufacturers it is miscible with lime sulphur and Bordeaux mixtures. The reason for this is that one of the active components which is contained in certain "Schradan" products and which is decomposed when the mixture is prepared does not exist in "Schradan 2".

"Schradan 1" contains the same active ingredient, in equal quantity, as "Schradan 3".

### Bis(isopropylamido)fluorophosphate

The preparation contains 90 % bis(isopropylamido)fluorophosphate (proposed group designation is "Mipafox"), and has the following structural formula:



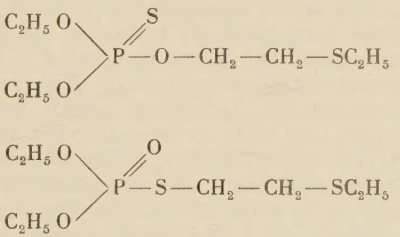
It is a white, crystalline powder which is difficultly soluble in water. In addition to being systemic, it also possesses a good contact effect. Therefore bis(isopropylamido)fluorophosphate does not act on useful predators and parasites until after it has been absorbed by them. Under normal growing conditions, the preparation is absorbed by the leaves in 1½ to 2 days. The systemic effect lasts 6 to 7 days, although the decomposition in the plant is said to commence after 3 to 4 days. In the soil this process is much slower. Bis(isopropylamido)fluorophosphate is effective chiefly against mites and aphids but it is credited with having a good effect also against thrips, whiteflies, woolly aphids and scales. As a result of its rapid transformation in the plants, one week ought to suffice between the last application and the harvest. The preparation is miscible with practically all insecticides and fungicides but not with lime sulphur and Bordeaux mixtures.

## "Systox"

The commercial preparation "Systox" contains 50 % active ingredient and 50 % emulsifier (polyethylene glycol ether). The active ingredient itself consists of 2 components:

1. 65 % diethyl thionophosphoric ester of β-oxyethyl thioethyl ether, and
2. 35 % diethyl thiolphosphoric ester of β-oxyethyl thioethyl ether.

The structural formulae of the two compounds are as follows:



"Systox", too, was discovered by the German chemist G. Schrader. The preparation is a brown, oily liquid, difficultly soluble in water. In aqueous emulsion, the active ingredient, as a result of its lipide-solubility, is able to penetrate rapidly into the plant. Until the spray deposit dries, the preparation has a good contact and vapour action. Despite this, it has, however, been observed that the fully developed stages of predators *(Coccinella spec.)* are not harmed even when they receive a direct hit by the spray wash. On the other hand there are certain larval stages of these predators which are sensitive, and are killed on coming into contact with the spray. After the preparation/active ingredient has penetrated into the green parts of the plant, the systemic effect is unfolded. This is then more or less selective and is confined to aphids and spider mites. The first pests are killed after 5 to 9 hours. Within 12 to 24 hours 100 % mortality may be registered. The period of effectiveness for the spray method is 2 to 3 weeks, and for the sprinkling method 4 to 6 weeks. With respect to treatment by sprinkling, Unterstenhöfer (1950) reports that very little "Systox" is retained by the soil as a result of absorption.

During a lecture given at the Pest Control Congress held in September 1952 in Paris, Dr. G. S. Hartley maintained that when "Systox" is sprayed, only about one-quarter of the active ingredient is absorbed by the leaves *).

The vapour pressure of the active ingredient is quoted by Schrader (1952 b) as being 15.5 mg/cc at 20 ° C. In face of this high volatility, one would expect the period of effectiveness to be very short. However, there are apparently certain cell elements present in the living plant (lipides) which are able to retain the active ingredient for long periods, and to give it off into the atmosphere only at slow rates.

According to Schrader (1952 a), "Systox" rearranges itself at high temperatures in such a manner that the double-bonded sulphur at the phosphorus atom is replaced by the oxygen present at the ethyl mercaptoethyl. This oxygen isomer, which is available in the commercial preparation up to about 35 %, has a high toxic value. A characteristic of the thiol compound is its high water solubility of approximately 1:500 while the thiono compound is only 1:15,000 soluble in water. An isomerization of the thiono compound to form the thiol compound does not occur at normal temperature although it might be thought that such rearrangement processes could take place in the living plant. Even if only a part of the thiono compound in the living plant were to be transformed into the thiol compound, a higher degree of translocation would ensue as a result of the improved water solubility, and moreover due to the high toxicity there would be a better effect against pests on the plant.

The investigations carried out by Heath (1953) with "Systox" produced the following result: The active ingredient consists of two isomers, the thiono compound and the thiol compound. He estimates the isomer ratio to be 50:50. Heath is of the opinion that the thiono compound in the plant is transformed into the thiol compound within 2 to 3 days. This oxygen isomer is further decomposed into water-soluble derivatives which are less effective against pests and which are also less toxic to warmblooded animals. The thiono compound, in other words the sulphur isomer, is also transformed into water-soluble derivatives. Their toxicity has not been examined. On the basis of the fact that the oxygen isomer is 10 times as toxic as the thiono compound, Heath assumes that it plays the greater part in the effect exerted upon the pests.

Schrader (1952 b) is of the opinion that "Systox" in the plant is not decomposed but that it is slowly given off as a vapour. Contrary to this, the Chemagro Corp. (1952) maintain that "Systox" is decomposed in the plant, and that the decomposition products are not toxic. Whether "Systox" actually undergoes transformation in the plant or whether it is given off as vapour in its applied form is a question which has not yet been completely clarified. Analyses and tests (U.S.A. and Germany) show that at all events the poison disappears completely from the plant after 4 to 6 weeks. The detoxication period varies according to the season, the plant species and the temperature. The selective effect of "Systox" covers mites, aphids, woolly aphids, scales, mining larvae and eelworms. When the concentration applied is increased it is also possible to produce a certain effect against other pests. Except for lime

*) Editor's note: This assertion is countered by Tietz (1954) who proved by means of a $^{32}P$-labelled compound that at least 40 % to 50 % of the applied solution is absorbed by the green parts of the plant. Tietz, H.: Der mit $^{32}P$ markierte Diäthylthionophosphorsäureester des $\beta$-Oxäthylthioäthyläthers (Wirkstoff des systemischen Insektizides „Systox"), seine Aufnahme in die höhere Pflanze und sein Wanderungsvermögen. —Höfchen-Briefe, No. 1, 1954.

sulphur and Bordeaux mixtures, "Systox" is miscible with all the usual types of insecticides and fungicides. According to investigations made in America, it should not, as far as possible, be mixed with organic mercury compounds.

### Absorption and Translocation in the Plant

Systemic preparations are absorbed by the leaves or the roots, and transported to other parts of the plant. Due to their lipide-solubility they can easily diffuse through the semi-permeable cell membranes in the transport system. Absorption is quickest on young, active leaves which have just unfolded, and slower on very young leaves and on older leaves which have fully developed. Absorption through the abaxial surface of the leaf is about three times as fast as through the adaxial surface. The reason for this might be attributed to the far larger number of stomata on the abaxial surface of the leaves.

Since the plant sap is the only means of transport that can be considered, a systemic preparation must be both soluble in water and stable (Hartley 1951). As is known, plants have two transport systems. In the xylem, water and salts from the soil are transported upwards through the stem to the leaves, blossom and fruits (upward moving sap stream or transpiration stream). In the phloem, the assimilation products, i. e. a solution of sugar and nitrogenous amino acids, are transported in a downward direction although to a certain degree they are also transported upwards (downward moving sap stream or assimilation stream).

Once a systemic preparation has been absorbed by the roots of the plant, it is transported by the transpiration stream in the xylem to all organs above ground. On the other hand, following a treatment of the organs above ground (spray), it is only able at first to reach the leaf veins as a result of diffusion in the leaf. From here it migrates in the phloem into the shoot axis, and is able to move in the phloem both in an upward and downward direction.*)

The translocation of the systemic preparation from the leaf following a spray treatment can suffice to provide the young, newly developed parts of a plant with adequate quantities of insecticide. It was for this reason that Johansen (1952) was able to observe that aphids had been killed on chrysanthemum shoot tips which had developed after the plants had already been sprayed with either "Schradan 3" or "Systox". For the practical control of mites, however, no significance can be attached to the quantities of displaced preparation (Wallace 1951).

### Systemic mode of action

The action of systemic phosphoric ester preparations must actually be a stomach action caused by mites and aphids consuming the poisoned plant sap. With respect to "Systox" the position is not quite clear. Untersten-höfer (1952) has proved experimentally that "Systox" evaporates or is given off from the leaves in vapour form, and that aphids and mites which suck the plants are killed because they live in a "toxic" milieu. It might, therefore, be well assumed that in conjunction with the sucking of the plant sap

*) Editors's note: When the transport water of the phloem passes over to the xylem, a small quantity of the systemic preparation is carried over with it, namely to the xylem. Thus a renewed upward translocation takes place with the transpiration stream (Tietz, 1954).

there is also a certain stomach effect. Experimentally, it is difficult to furnish proof of this. In the U.S.A. (Chemagro Corp.) one speaks of a pure stomach effect. Probably it is a combined vapour and stomach effect. In tests he carried out with "Systox" against banana flies, Lusis (1952) established that a moist spray deposit has an extensive vapour effect whereas a dry deposit on surfaces receptive to absorption (leaves) has little or no vapour effect. An exception is created when the surface is moistened again. Furthermore it was confirmed that "Systox" is given off from leaves as a vapour. The vapour is condensed, and the condensate has a great insecticidal effect. In the immediate vicinity of the leaf surface the concentration is so high that certain species of sucking pests are killed. From this Lusis concludes that mining pests must also be killed. Tests carried out with "Systox" in Norway confirm Lusis's assumption since good results were also obtained against mining larvae.

## Toxicity

On the whole the toxicity of "Schradan" preparations and "Systox" to humans and animals is taken to be about equal to that of thiophosphorous preparations ("E 605" — "Parathion"). "Schradan" in plants and animals is transformed into other compounds as a result of an enzyme reaction. These compounds greatly inhibit the cholinesterase and cause symptoms of poisoning (Du Bois, Johansen 1952). These processes do not appear to take place with any particular rapidity. This would explain the poor initial effect against insects. Johansen (1952) found that extracts taken from chrysanthemum leaves which had been sprinkled a week earlier with 0·1 % "Schradan" killed 84 % of the chrysanthemum aphids by contact action, while only 21 % were killed by the extract from untreated chrysanthemum leaves mixed with 0·1 % "Schradan". The plants, therefore, decompose "Schradan" to form toxic compounds.

The make-up of the decomposition products, their high degree of toxicity and their relationship to the "Schradan" preparation in its original form when applied, are points which have not been fully clarified (Schrader 1952 b, Casida et al. 1952). In active growing plants they are not stable and are not accumulated. Within 3 to 4 weeks "Schradan" is transformed in the living plant, and after approximately six weeks the decomposition products disappear (Ripper et al 1951). These processes last several months when the treatment is carried out in Autumn or Winter.

The acute toxicity of "Schradan" at LD 50 (lethal dose for 50 % of the test animals) is 10 to 18 mg/kg for rats (Fletcher 1951).

In the case of bis(isopropylamido)fluorophosphate the danger of an acute poisoning is not so great as with "Schradan". Fletcher (1951) reports the LD 50 for rats as being 80 mg/kg. There is the possibility that the preparation may cause paralysis. For this reason it is no longer used for the time being as a spray in Norway. It is, however, still used in greenhouses in capsule form. Fletcher (1951) gives the acute toxicity (LD 50) of "Systox" as 14 mg/kg for rats. (Other authors arrived at values of 12 mg/kg [Wirth] and 9 mg/kg [Chemagro Corp.] respectively). It is not accumulated since approximately 16 % of the lethal dose administered daily to rats does not cause poisoning. "Systox" produces symptoms of poisoning which correspond to those caused by the decomposition processes of "Schradan". It also acts strongly

*Table 1.* Tests with systemic phosphorus preparations against European red mites *(Paratetranychus pilosus* C. and F.) 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after 2 weeks | 3 weeks | 6 weeks | Remarks |
|---|---|---|---|---|---|---|---|
| I Skoger | 1) "Schradan 3" | 0·1 | 4 June | 100 | | | The test was carried out on 2 apple trees *(Filippa)* in each test row. Checks made on 200 leaves per test row. On the unsprayed trees, in the five test rows, 127, 489, 94, 144 and 594 living mites were found respectively per 100 leaves. |
| | „ | 0·1 | 4 and 18 June | | 100 | 59·6 | |
| | „ | 0·1 | 18 June | | 79·8 | | |
| | „ | 0·1 | 18 June and 6 July | | 96·8 | | |
| | 2)"Systox" | 0·05 | 4 June | 100 | | | |
| | „ | 0·05 | 4 and 18 June | | 100 | 85·1 | |
| | „ | 0·05 | 18 June | | 98·6 | | |
| | „ | 0·05 | 18 June and 6 July | | 98·6 | | |
| II Hurum | "Systox" | 0·05 | 25 June | 100 | approx. 90 | | The test was carried out on apples *(Filippa)*. Checks on 50 leaves per tree. |
| III Lier | "Systox" | 0·05 | 11 June | 100 | approx. 90 | | The test was carried out on apples *(Säfstaholm* and *Transparente)*. Checks on 50 leaves per tree. |
| IV Rygge | 3) "Schradan 1" | 0·1 | 11 June | 100 | | | The test was carried out on apples. 8 trees to each test row, divided into 2 parallels. Checks on 200 leaves per test row. On unsprayed trees 256 living mites per 100 leaves. |
| | „ | 0·1 | 11 and 24 June | 100 | | | |
| | "Systox" | 0·05 | 11 June | 100 | | | |
| | „ | 0·05 | 11 and 24 June | 100 | | | |
| V Lofthus | 4) "Schradan 2" | 0·1 | 26 May | 77·7 | | | The test was carried out on plums. 20 trees to each test row, divided into 2 parallels. Checks on 200 leaves per test row. On unsprayed trees 717 and 209 living mites per 100 leaves. |
| | „ | 0·1 | 26 May and 11 June | | 96·2 | | |
| | "Systox" | 0·05 | 26 May | 90·9 | | | |
| | „ | 0·05 | 26 May and 11 June | | 98·6 | | |
| | | | | No. of weeks after last spraying | | | |

1) 66% Octamethyl pyrophosphoramide ("Ompa")
2) 50% Diethyl-ethyl mercaptoethyl thiophosphate
3) 66% Octamethyl pyrophosphoramide ("Ompa")
4) 70% „ „ ("Ompa")

cholinesterase-inhibiting. Compared with "E 605", the danger of absorption through the skin of rats is much greater with "Systox" (Schrader 1952 a).

Heath (1953) examined the toxicity of isomers. He reported the LD 50 of the thiono compound to be 20—30 mg/kg for rats, 2 mg/kg for the thiol compound, and 6—10 mg/kg for the decomposition products in the plants.

### Tests with systemic preparations

In 1950 to 1952 greenhouse and outdoor tests were carried out on fruit trees, berries, cereals and ornamental plants with the commercial preparations bis(isopropylamido)fluorophosphate, "Schradan 3", "Schradan 2", "Systox" and "Schradan 1". The greater part of the tests was devoted to mites and aphids, while on a lesser scale the effect of the preparations against nematodes, gall mites, woolly aphids, scales, larvae of mining moths and flies was also examined.

#### Fruit trees

The tests covered orchard mites (*Paratetranychus pilosus* C. and F.), green apple aphids (*Aphis pomi* Deg.), rosy apple aphids (*Yezabura malifolii* Fitch.), *Aphis crataegi* Kalt. or *Yezabura devecta* Walk., mealy plum aphids (*Hyalopterus arundinis* Fab.), green plum aphids (*Aphis pruni* Re. or *Anuraphis helichrysi* Kalt.?) and cherry aphids (*Myzus cerasi* Fab.). (See Tables 1 to 4 and the summary of the results obtained in the practical tests carried out in 1952.)

Table 1 shows that all the preparations had an excellent effect over a period of three weeks. The check carried out in Test 1 after three weeks showed that a better result was obtained with two sprays on June 4 and 18 (pre-blossom and post-blossom) than with only one spray applied on June 18 (directly following the blossom period). A pre-blossom spray had a better effect than a post-blossom spray, whereas with a spray both before and after the blossom period a better result was produced than with a spray immediately the blossom period was over and another one three weeks later (July 6). The emergence of the larvae from the winter eggs in 1951 was earlier than usual.

In Test IV it was observed at the same time that there was a heavy infestation of fruit leaf miners (*Lyonetia clerckella* L.). On July 1, 30 larvae taken from each test row were examined. 16 larvae (53·3 %) were killed by "Systox" and 1 larva (3·3 %) by "Schradan 1".

In the test at Lofthus (Test V on plums) a 100 % effect was not produced. The personnel carrying out the experiment reported that the larvae had emerged from all the winter eggs before the first spray was applied on May 26 (immediately following the blossom) and that the trees were sprayed with a combination of "DDT" and Bordeaux mixture on June 6. It is probable that in this case the result was influenced by summer eggs present before the first spray and the "DDT" spray were carried out.

In these tests, it is seen that as regards the effect there is no considerable difference between the "Schradan" preparations and "Systox" since the sprays were applied in good time and during the period when growth was most vigorous. Our investigations show that the effect of "Schradan" is less satisfactory when sprays are carried out at a late date, a fact also borne out by the Swedish tests.

Table 2 shows that the effect remains persistent for fourteen days even following a severe infestation. In Test XII, in which "Systox" was compared with 40 % nicotine sulphate and a thiophosphorus preparation, winged aphids were living eight days following the application of the nicotine and thiophosphorus sprays, and were capable of reproduction. This observation was not made until 14 days following the treatment on the trees sprayed with "Systox".

Test XIII shows that as the spray was not applied until July 27 "Schradan 3" did not produce a useful effect, this being due to the fact that this type of preparation is far more dependent upon the vigorous growing power of the plants than "Systox". Sprays carried out with "Schradan" preparations in May and June produced an excellent effect (Tests X—XI and XIV).

*Table 2.* Tests with systemic phosphorus preparations against the green apple aphid (*Aphis pomi* Deg.) 1951—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after 1 day | 3 days | 8 days | 14 days | Remarks |
|---|---|---|---|---|---|---|---|---|
| VI Lier-Skogen | "Systox" | 0·05 | 21 May | 100 | | 100 | | |
| | „ | 0·025 | 21 May | 100 | | 100 | | |
| VII Lier | "Systox" | 0·05 | 29 May | 100 | | | | 100 % effect after 12 hours. |
| VIII Lier | "Systox" | 0·05 | 6 June | 100 | | 100 | | After 17 days another weak infestation occurred. |
| IX Lier | "Systox" | 0·05 | 11 June | | | 100 | | Very heavy infestation before the treatment. |
| X Rygge | "Schradan 1" | 0·1 | 23 June | | 100 | | | |
| XI Rygge | "Systox" | 0·05 | 11 and 24 June | | 100 | | 100 | Severe infestation before the application. |
| | "Schradan 1" | 0·1 | 11 and 24 June | | 100 | | 100 | |
| XII Lier | "Systox" | 0·05 | 28 June | 100 | 100 | 100 | 12 days 100 | Renewed infestation after 14 days. |
| XIII Lier | "Schradan 3" | 0·1 | 27 July | 20 | 20 | | | Very severe attack prior to treatment. |
| | "Systox" | 0·05 | 27 July | 100 | 100 | 100 | | |
| | | 0·025 | 27 July | 95 | 100 | 100 | | |
| XIV Uskedal | "Schradan 2" | 0·1 | 3 and 12 May | | | 100 | 22 days 100 | Two pre-blossom sprays. Slight to medium infestation. "Schradan 2" caused slight spray damage to the leaves. |
| | "Systox" | 0·05 | 3 and 12 May | | | 100 | 100 | |
| | „ | 0·025 | 3 and 12 May | | | 100 | 100 | |
| | „ | 0·05 | 12 May | | | 100 | 100 | |

Table 3 shows that systemic preparations also have a good effect against the rosy apple aphid *Yezabura malifolii* Fitch. This species is now just as widely propagated over the whole country as the green apple aphid *Aphis pomi* Deg. The effect in Test XVII was just as excellent against *Yezabura devecta* Walk. which had slightly attacked the Gravenstein variety.

*Table 3.* Test with systemic phosphorus preparations against the rosy apple aphid *(Yezabura malifolii* Fitch.) 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after 3 days | Effect in % after 14 days | Remarks |
|---|---|---|---|---|---|---|
| XV Rygge | "Schradan 1" | 0·1 | 23 June | 100 | | Heavy infestation before treatment. |
| XVI Jar | "Schradan 3" | 0·1 | 26 June | 96·3 | | Heavy infestation before treatment. |
| | "Systox" | 0·05 | 26 June | 100 | | |
| XVII Rygge | "Schradan 1" | 0·1 | 11 and 24 June | 100 | 100 | Heavy infestation before treatment. |
| | "Systox" | 0·05 | 11 and 24 June | 100 | 100 | |

Table 4 shows that even at such a low concentration as 0·025 %, "Systox" is sufficiently effective against the mealy plum aphid. The addition of a wetter had no influence on the result, nor did the fact that the sprays were carried out late. The sprays were applied in the evening at a temperature of 13 ° C. 40 % nicotine sulphate in a 0·25 % concentration with an addition of 1 % soft soap had a most adequate effect against the mealy plum aphid.

The good effect against cherry aphids is confirmed by tests carried out in America (J. E. E., 44, P. 1012).

*Table 4.* Tests with systemic phosphorus preparations against the mealy plum aphid *(Hyalopterus arundinis* Fab.) and the cherry aphid *(Myzus cerasi* Fab.) 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after ½ day | 1 day | 2½ days | 5 days | 14 days |
|---|---|---|---|---|---|---|---|---|
| XVIII Lier (mealy plum aphid) | "Systox" [1]) | 0·05 | 13 July | 80 | 100 | | 100 | |
| | "Systox" [1]) | 0·025 | 20 July | 90 | 98 | 100 | | |
| | "Systox" | 0·025 | 20 July | 90 | 98 | 100 | | |
| XIX Ås (cherry aphid) | "Schradan 3" | 0·15 | 9 June | | | | 100 | 100 |
| | "Systox" | 0·05 | 9 June | | | | 100 | 100 |

[1]) Wetter added

## Practical Tests in 1952

For the purpose of studying the effect of "Schradan" and "Systox" against mites and aphids under different climatic conditions, a series of practical tests was carried out in the large fruit growing districts. The tests were carried out by 28 teams in 40 fields located in different provinces as follows: Buskerud 10, Vestfold 2, Östfold 3, Vest-Agder 4, Hedmark 2, Oppland 2, Hordaland 3, Sogn and Fjordane 14. A total of approximately 15,000 to 20,000 fruit trees were included in the tests.

It was planned on a broad basis to compare the effect of a "Schradan" preparation with that of "Systox" when applied before the stem formation of the blossom (1st pre-blossom spray) and immediately before the blossom (2nd pre-blossom spray) against aphids.

In addition, sprays were applied against European red mites both before and after the blossom period, and compared with control measures taken immediately following the blossom and again 2 to 3 weeks later. In several fields the effects of one and two sprays were compared with each other. The preparations were applied separately. After 24 hours, fungicides were also applied in certain locations. Winter sprays had not been carried out on the test fields. On all the fields, "Schradan" and "Systox" were used against aphids and European red mites in concentrations of 0·1 % and 0·05 % respectively.

*European red mites*

The results of the tests carried out in Buskerud against European red mites occurring on apples, representing the average for 6 fields, showed that both "Schradan" and "Systox" have a very good effect. Two sprays carried out before and after the blossom (May 19 and June 10) produced a more exact result than two other sprays, the first of which was applied after the blossom and the second three weeks later (June 10 and June 30). In the case of the sprays carried out after the blossom period was over, mites which hatched early had already inflicted a certain amount of damage during the blossom, and moreover they had commenced to lay summer eggs. The temperature during pre-blossom sprayings was 7 to 8 ° C, and immediately after the blossom 12 to 13 ° C. A check carried out several hours following the application of the spray showed that young mites were killed at once, whereas fully-grown mites were not eradicated until 3 to 4 days later. On the whole, the fields were free of mites (and aphids) throughout the entire season.

Four fields were sprayed only once immediately following the blossom period (June 5 to 7). Checks carried out at intervals of 1, 5, 10 and 16 days, and spot checks made later on in the season, showed that both "Systox" and "Schradan 1" had an excellent effect. The brood of several summer eggs laid during the blossom period emerged at different intervals following the application of the sprays. Most of the newly-hatched mites were killed immediately they began to suck the sap.

One spray with "Systox" was almost as effective as two sprays, which was not the case with "Schradan 1". In three fields the spraying teams had also used a DMC preparation (special preparation against mites) for the purpose of drawing comparisons. Practically speaking, the effect against the mites was

just as good as that of the systemic preparations, although against aphids DMC was ineffective.

The comparison made between sprays carried out with "Schradan 1" and "Systox" following the blossom (June 16), and again three weeks later, on very heavily infested apple trees in Oppland showed that both preparations produced a good effect. Three days following the first spray with "Systox" all the mites were dead, whereas on the trees treated with "Schradan 1" there were still a few living mites present. Since neither of the preparations is effective against summer eggs, which were laid in large numbers during the blossom period, it was necessary to apply two sprays in order to obtain a 100 % effect during the whole season.

In Östfold "Systox" was tested as a pre-blossom spray (May 16) on apples and plums. The result was extremely satisfactory since no mites were found during the first five weeks following the treatment. The check carried out after three months uncovered a new infestation. Sprays before and after the blossom did not have a much better effect than a single pre-blossom spray.

In the tests carried out on apples in Vestfold it was established that a single "Systox" spray immediately following the blossom (June 9) was just as effective as two sprays, one just after the blossom and another 3 weeks later. After 12 hours the preparation had still not started to act, but two days later it had become fully effective and remained persistent at least four weeks. Later, single mites were found. In this test the effect of "Schradan" was most unsatisfactory (checks after 12 hours, 2, 4, 10 and 30 days). It is difficult to make any comments about the reasons for the poor effect in this test. However, as the spray was carried out at a very low temperature and late in evening with a heavy dew afterwards, it is possible that these factors had some influence upon the resultant effect.

On three fields in Vest-Agder which were sprayed immediately following the blossom and again two weeks later, the effect produced by "Schradan 1" was good and in fact it lasted for three weeks after the last spray. The effect obtained with "Systox" was excellent.

In Sogn and Fjordane (5 fields), a pre-blossom spray (May 14) applied to apples was just as effective as a spray carried out immediately after the blossom (May 31). The effects produced by "Schradan 3" and "Systox" were more or less equal. The pre-blossom and post-blossom sprays (May 10 and May 25) produced the most reliable effect. The temperatures prevailing during spraying were 20 $^{0}$ and 13 $^{0}$ C respectively. The preparation was still fully effective two days after its first application. 38 days following the last spray several mites were discovered, although the checks carried out 48, 70 and 110 days later revealed that the intensity of the infestation had not increased. Due to the fact that they were carried out late, "Schradan 1" sprays applied immediately following the blossom and again three weeks later (May 27 and June 14) were not sufficiently effective to rid the fields of mites for the whole of the season. Moreover, the temperature at the time of the first spray was only 7 $^{0}$ C. "Systox" sprays applied to plums immediately following the blossom (May 26) and again 2 weeks later remained fully effective for a period of four weeks after the second spray. Single mites were discovered in the checks carried out 50 and 110 days following the second spray. The temperatures during spraying were 13 and 15 $^{0}$ C respectively.

*Aphids*

In most of the tests carried out at Buskerud, there were infestations by rosy and green apple aphids, and to a lesser degree by *Yezabura devecta*. 2 sprays with "Systox" applied before the stem formation of the blossom and immediately prior to the blossom period itself (May 16) were very effective, although the effect of one spray carried out just before the blossom stem formation was just as good. A good effect was established already 6 to 7 hours following the spray (against mites not until after 3 days). "Schradan 1" and "Systox" were both very effective as pre-blossom and post-blossom sprays (May 19 and June 10). The temperatures during spraying were 8 and 12° C respectively. The check carried out two days following the first spray showed that all the aphids had been killed by "Systox", while on the trees sprayed with "Schradan" there were still a few adult aphids alive. After two sprays, all the aphids were killed. Poor results were obtained with both preparations when sprayed immediately prior to the blossom period and again three weeks later. From the check carried out seven hours following the first spray (June 10) it was established that many adult aphids were living in the small, rolled-up leaves, whether rosy apple aphids, green apple aphids or *Yezabura devecta*. Following the second spray, the effect of both preparations was relatively good, and it persisted throughout the entire season. As the aphids had inflicted a large amount of damage both before and during the blossom period, the two sprays must be regarded as having been carried out too late to be of any practical value in the control of aphids.

One "Systox" spray applied immediately following the blossom (June 7 on three fields) against rosy and green apple aphids proved to be 100 % effective after three days. Three weeks later, however, alate aphids and juveniles had made a reappearance on several tips. Pre-blossom and post-blossom "Systox" sprays (May 20 and June 11) directed against *Yezabura devecta* resulted in a 100 % kill.

The effect produced by a single "Systox" spray applied against the apple leaf sucker (*Psylla mali* Schm.) was slight to zero.

In the tests carried out in Hedmark and Vestfold, the results obtained with a single post-blossom "Schradan 3" spray against green and rosy apple aphids were not at all satisfactory. The best effect was against the green apple aphid. Two post-blossom sprays applied against plum aphids were also unsatisfactory. The sprays carried out with "Systox" before the stem formation of the blossom and before the blossom period (May 14 and May 23) against aphids occurring on apples produced an excellent effect. Four weeks following the second spray the effect was still 100 %. According to the team carrying out the tests, the same preparation sprayed once against rosy and green apple aphids immediately following the blossom period (June 9) was just as effective as when sprayed several times in the post-blossom period.

In Östfold, one spray with "Systox" + lime sulphur and one spray with "Systox" without an addition of lime sulphur were applied to apples just prior to the stem formation of the blossom (May 9) (spray with lime suphur 24 hours later). The check showed that the effect obtained with both sprays was not 100 % 40 days following spraying. 47 days following the application, several cases were found of winged aphids occurring on the tops of the trees, although later on, during the actual season, the infestation was weak. "Systox" mixed with lime sulphur did not cause any spray damage and the results were just

as good as those obtained with the "Systox" wash to which no lime sulphur had been added. The results obtained with sprays applied to apples and plums before the blossom period (May 16) corresponded to those obtained with the sprays carried out before the stem formation of the blossom. The effect was just as good as with two sprays applied prior to and following the blossom period.

A 100 % effect was produced with a "Systox" spray applied immediately after the blossom period against aphids occurring on apples and plums in Vest-Agder (June 5). In Hordaland the spraying team was successful in producing a 100 % effect with "Systox" which persisted until the beginning of August by applying a pre-blossom and a post-blossom spray to apples (May 10 and June 11).

In Sogn and Fjordane (10 fields), a single "Systox" spray applied against rosy and green apple aphids and *Yezabura devecta* immediately before the stem formation of the blossom (May 2) was just as effective as a spray carried just before the blossom period (May 12). The first aphid-infested tips were observed 28 days following the treatment. When two sprays were applied before the blossom, living aphids were discovered 45 days later, and aphid-infested tips 60 days later. "Schradan" applied immediately preceding and following the blossom period was just as effective against the rosy and green apple aphids as "Systox". Since both preparations were 100 % effective following the first spray, it really would not have been necessary to apply a second spray, particularly as "Schradan", from a practical point of view, was just as effective immediately following the blossom. Aphid-infested tips were not observed in the checks until 41 days following the treatment.

According to the spraying team, *Yezabura devecta* was completely eradicated two days following a "Schradan" spray carried out on June 11. Rosy apple aphids were also completely killed off. The effect lasted 28 days after the application of "Systox" on July 5.

In the tests carried out in Fjordane against rosy and green apple aphids, "Systox" was very effective when applied as a pre-blossom spray (May 14). In the checks made 4, 22 and 44 days later, no living aphids were found. After a period of 50 days single aphids appeared, and after 80 days the tips were aphid-infested. With a "Schradan" spray applied on July 10, the preparation became fully effective after four days, although within eight days there were winged aphids on the tips. However, the checks made later showed that the infestation had not increased to any considerable extent. The fact that "Schradan" was not fully effective in this test was probably due to the spray being applied so late in the year. The spraying team reported that in one field "Systox" was not fully effective. However, when the remainder of the preparation from the same packing was tested later, it was found to have an excellent effect both against mites and aphids. One spray applied against the green plum aphid just before the stem formation of the blossom (May 2) produced a good effect lasting at least four weeks. The same applies to the spray carried out on June 9.

In these forty tests no effect was established with systemic preparations against pests other than mites and aphids, although there was one exception in Östfold, where a certain effect was obtained against fruit leaf miners (*Lyonetia clerckella* L.). Also a test carried out in Vest-Agder revealed a certain effect against the black plum sawfly (*Hoplocampa minuta* Christ.).

In the fields where such predators as *Anthocorus nemorum* L. larvae of *Chrysopa sp.* and *Syrphus sp., Coccinella septempunctata* L. and *Adalia bipunctata* L. and their larvae occurred, sprays with "Schradan" and "Systox" did not cause any noticeable reduction in the numbers of these useful insects.

The most important varieties in these tests were: Bramley Seedling, Gelber Richard, Cox Pomona, Filippa Fuhr, Gravenstein, James Grieve, Kaupanger, Laxton Superb, Prinsar, Ribston, Silke-eple, Transparente Blanche, Torstein, Wagener and Akerö. The following plum varieties were included in the tests: Jefferson, Reine Claude d/Quillins, Rivers Early, Prolific, Victoria together with several varieties of "Japanese" plums *(Prunus salicina).* No damage was caused by the systemic preparations in the fields where the tests were carried out. The spraying team in Buskerud believed, however, that the Leinestrand variety suffered a slight leaf discoloration following a spray with "Schradan 1". In this case the spray was applied shortly before the blossom period.

No harmful effect against bees was established in any of the test fields, not even in cases when the sprays were carried out immediately prior to the blossom period.

## Berries

From 1950—1952 three tests were carried out with systemic phosphorus preparations on berries, two against spider mites on strawberries and one against *Eriophyges sp.* on raspberries (see Tables 5 and 6).

Table 5 shows that the systemic preparations have a good effect. The number of living mites in the untreated test fields increased by more than fourfold in Test I in the period from June 27 to August 11. In all the tests the numbers of living eggs were counted. On June 27 there were no more eggs to be found on those fields treated with "Schradan" and "Systox". On August 11,

*Table 5.* Tests with systemic phosphorus preparations in comparison to thiophosphorus against spider mites *(Tetranychus sp.)* occurring on strawberries *(Ydun),* 1950—1951.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % following 3 weeks | Effect in % following 9 weeks | Remarks |
|---|---|---|---|---|---|---|
| I Norges Landbruks-hogskole | "Schradan 3" | 0·15 | 9 June | 97·8 | 81·5 | Test fields made up of 4 rows à 10 m, 2 parallels for each test series. In the unsprayed fields 178 living mites were counted per 100 leaves on June 27, and 736 on August 11. |
| | "Systox" | 0·05 | 9 June | 100 | 96·0 | |
| | "Bladan-E 605" | 0·03 | 9 June | 85·4 | under 1·1 | |
| | | | | | 6 weeks | |
| II Norges Landbruks-hogskole | "Systox" | 0·1 | 1 June | 100 | 99·2 | Plan as in Test I. In the unsprayed fields an average of 128 living mites were found per 100 leaves on June 20, and 1066 on July 13. |
| | "Bladan-E 605" | 0·04 | 1 June | 94·5 | 99·2 | |

however, 185 and 95 eggs respectively were counted per 100 leaves. In the untreated fields the numbers of eggs counted per 100 leaves on June 27 and on August 11 were 190 and 1355 respectively. In Test II the number of living mites per 100 leaves increased eight-fold between June 20 and July 13. Harvest results in Test II revealed that plants treated with "Systox" produced 107 g more fruit per plant than plants which were left untreated.

Tests against the cyclamen mite (*Tarsonemus pallidus* Banks) could not be carried out since there was no opportunity for doing so. In Germany, however, tests were carried out with 0·1 % "Systox". Three sprays applied immediately after the formation of the leaves produced very promising results.

Table 6. The checks were carried out by means of approximate estimates, whereby the shoots from all the test fields were examined under the stereomicroscope.

*Table 6.* Tests with systemic phosphorus preparations in comparison to thiophosphorus against *Eriophyges gracilis* Nal. on raspberries in 1952.

| Test No. | Preparation | % Concentration | Date of treatment | Approx. effect in % on | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | June 27 | July 12 | July 28 | Aug. 5 | Aug. 20 | Sept. 11 |
| III Hermansverk | "Systox" | 0·05 | 7 May and 12 June | 60 | 60 | 60 | 60 | 60 | 60 |
| | Thiophosphorus | 0·05 | 7 May and 12 June | 80 | 70 | 70 | 70 | 70 | 70 |

Untreated plants were very heavily infested, and the leaves of two-year shoots were yellow and wrinkled. By degrees the leaves of the annual shoots also turned yellow. One test field was sprayed before the blossom with nicotine sulphate and before the emergence with fruit tree carbolineum oil. The result of the treatment was negative. In the fields treated with thiophosphorus, only very few annual shoots were infested.

## Ornamental Plants in Greenhouses and Outdoors

As mites and aphids are the worst enemies of ornamental plants, many advantages are offered by systemic preparations, particularly in greenhouses. In addition to the usual method of spraying, the sprinkling process is also of great significance especially for the treatment of potted plants. Tables 7 to 13 provide a summary of the tests carried out with ornamental plants.

Table 7. Test I shows that by sprinkling "Systox", a 100 % effect can be produced lasting at least four weeks. In order to obtain a full effect with "Schradan" it was necessary to sprinkle the plants twice. When the check was made on September 17 many mites were discovered on the flower buds of the plants treated once with "Schradan", whereas after two treatments only very few mites were observed. In contrast to this result, no mites were found on the buds of the plants which were treated with one and two "Systox" sprays.

The immersion of the figs in Spring resulted in a full effect lasting three weeks for both preparations.

"Schradan" produced a better effect when sprayed against mites occurring on roses than when sprinkled (Johansen 1952), while "Systox" produced a

*Table 7.* Tests with systemic phosphorus preparations against the common spider mite or "red mite" *(Tetranychus althaeae* v. Hanst.) 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | No. of mites Aug. 28 | Sept. 11 | Sept. 17 | Remarks |
|---|---|---|---|---|---|---|---|
| I Norges Landbruks-høgskole | Sprinkling of carnations *(Dianthus carioph.)* in beds | | | | | | 5 litres of wash per sq. metre. The carnations were planted in May 1952 in beds with sub-irrigation. Check on 25 leaves per test row. |
| | "Schradan 3" | 0·1 | 20 August | 194 | 22 | 13 | |
| | "Schradan 3" | 0·1 | 20 August and 1 September | | 6 | 0 | |
| | "Systox" | 0·05 | 20 August | 66 | 0 | 0 | |
| | "Systox" | 0·05 | 20 August and 1 September | | 0 | 0 | |
| | | | | Effect in % after | | | |
| | Immersion of figs *(Ficus carica)* | | | 1 week | 2 weeks | 3 weeks | |
| II Lilleaker | "Schradan 3" | 0·1 | 8 June | 100 | 100 | 100 | Heavy pre-treatment infestation. Check on 10 leaves per plant. |
| | "Systox" | 0·05 | 8 June | 100 | 100 | 100 | |

good result in both methods of application. An application of a 0·025 % concentration of "Systox" against spider mites occurring on *Hydrangea* by sprinkling the plants was just as effective as with concentrations of 0·05 % and 0·1 % (Bosse 1952).

Table 8. Only young or newly hatched mite larvae were found four days after the treatment, and later. This test reveals that the mites are killed shortly after they start to suck the leaves. The figures for both preparations

*Table 8.* Test with systemic phosphorus preparations on roses against the common spider mite or "red mite" *(Tetranychus althaeae* v. Hanst.) which is resistant to thiophosphorus preparation.

| | Preparation | % Concentration | Effect in % after 1 day | 2 days | 3 days | 4 days | 6 days | 10 days | 14 days | 18 days | 23 days |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Test III, Oslo 1951 | Sprayed on Sept. 4 | | | | | | | | | | |
| | "Schradan 3" | 0·1 | 67·5 | 70·0 | 97·0 | 94·0 | 97·1 | 97·7 | 95·3 | 98·9 | 95·9 |
| | "Systox" | 0·05 | 80·0 | 87·5 | 100 | 100 | 99·3 | 97·7 | 100 | 100 | 98·6 |
| | Thiophosphorus | 0·05 | | | | 15·0 | | | | | |
| | Sprinkled on Sept. 4 | | | | | | | | | | |
| | "Schradan 3" | 0·125 | 0 | 0 | 36·0 | 75·0 | 76·4 | 55·6 | 79·1 | 92·2 | 72·8 |
| | "Systox" | 0·075 | 0 | 0 | 5·0 | 75·0 | 67·8 | 85·6 | 76·7 | 84·4 | 83·0 |
| | "Systox" | 0·040 | 0 | 0 | 5·0 | | 41·1 | 46·6 | 76·7 | 77·8 | 15·0 |

show that by spraying the cultures, a better effect is obtained than by sprinkling. It is to be assumed that the less satisfactory effect produced by the sprinkling method is to be attributed to the fact that the absorption of the preparation through the roots and its translocation in the plants did not mature sufficiently as to produce the desired degree of success. On the other hand there is also the possibility that the preparations are flushed out when the plants are sprinkled in the usual way. In the field, two to four treatments ought to suffice to rid plants of common and resistant mite species for the whole of the season.

Table 9 shows that in these tests "Systox" produced better results than "Schradan" when applied in late Summer. Those mites which survived the treatments were all found hiding in the flowers.

*Table 9.* Spraying tests with phosphorus preparations against aphids *(Aphididae)* 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after 3 days | 5 days | 19 days | Remarks |
|---|---|---|---|---|---|---|---|
| IV Oslo | Dahlia *(Dahlia c.)* | | | | | | |
| | "Schradan 3" | 0·15 | 8 Aug. | | 95 | | Outdoor plants. Heavy pre-treatment infestation. |
| | "Systox" | 0·05 | 8 Aug. | | 100 | | |
| V Oslo | Zinnia | | | | | | |
| | "Schradan 3" | 0·1 | 24 Aug. | | 100 | 90 | Plants set at random in greenhouse. Heavy pre-treatment infestation. Temperature 18° C. Constant attacks by winged aphids flying over from untreated plants. |
| | "Systox" | 0·05 | 24 Aug. | | 100 | 100 | |
| VI Oslo | Carnations *(Dianthus carioph.)* | | | | | | |
| | "Schradan 3" | 0·075 | 19 June | 87·3 | 91·0 | | Annual carnations indoors. Temperature 19° C. On untreated plants 155 aphids per 5 plants. Checks could not be made later due to spraying team having to carry out own applications. |
| | "Schradan 3" | 0·15 | 19 June | 93·1 | 95·2 | | |
| | "Systox" | 0·025 | 19 June | 100 | 100 | | |
| | "Systox" | 0·05 | 19 June | 100 | 100 | | |
| VII Oslo | Roses *(Rosa sp.)* | | | | | | |
| | "Systox" | 0·05 | 10 July | 100 | | | 4 weeks following treatment occurrence of new aphid colonies on tips. |
| VIII Oslo | Jasmines *(Philadelphus sp.)* | | | | | | |
| | "Systox" | 0·05 | 7 Aug. | approx. 99 | | approx. 95 | Heavy infestation before treatment. After 24 hours approximately 98% effect. Three weeks following treatment occurrence of new aphid colonies. |
| IX Bestun | Chrysanthemums *(Chrysanthemum hort.)* | | | | | | |
| | Bis(isopropylamido)fluorophosphate | 0·1 | 12 March | 100 | | | Peach aphid *(Myzus persicae* Sulz.) 100% effect within 24 hours. |

Test VI in Table 9 reveals that "Systox" applied at a concentration of 0·025 % was just as effective as when applied at a concentration af 0·05 %.

Table 10. In Test X both preparations showed a better effect on old plants when sprayed than when sprinkled. Test XI, carried out with bis(isopropylamido)fluorophosphate, revealed that a speedier effect is obtained by spraying. Aphids with which the plants were infected three days following the treatment were killed within a period of four days (7 days following the treatment), whereas a 100 % knockdown was not obtained against aphids with which the plants were colonized seven days after the application. Sprinkled plants which were colonized with aphids were completely rid of the pests three days following the treatment. The effect lasted 23 days.

*Table 10.* Spraying and sprinkling tests with systemic preparations against aphids *(Aphididae)*, 1950—1952.

| Test No. | Preparation | % Concentration | Date of treatment | Effect in % after 1 day | 3 days | 7 days | 16 days | 19 days | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | *(Primula obconica)* | | | | | | | | |
| X Oslo | "Schradan 3" | 0·1 | Spraying 25 Aug. | | 98·0 | | | | Approx. 100 aphids per plant before treatment. Temperature 19° C. Large blossoming plants in 11 cm pots. 50 ccs. of wash per pot. Not possible to make checks later due to spraying team having to carry out own applications. |
| | "Systox" | 0·05 | 25 Aug. | | 100 | | | | |
| | "Schradan 3" | 0·125 | Sprinkling 25 Aug. | | 30·0 | | | | |
| | "Systox" | 0·05 | 25 Aug. | | 99·5 | | | | |
| | *(Pelargonium peltatum)* | | | | | | | | |
| XI Bestun | Bis(isopropylamido)-fluorophosphate | 0·1 | Spraying 12 March | 100 | 100 | 100 | 90·0 | | Approx. 20 aphids per plant before treatment. Infested with 20—40 and 120 aphids resp. per 4 plants 1—3 days and 7 days following treatment. |
| | Bis(isopropylamido)-fluorophosphate | 0·2 | Sprinkling 12 March | 70·0 | 100 | | 100 | 100 | Sprinkled with 50 ccs. of wash per pot (9 cm). Infected with 150 and 100 aphids respectively per 5 plants 6 and 16 days following treatment. |

Table 11, Test XII. The temperature during the period of the treatment was 9° C. Later it fluctuated between 10 and 15° C. Most of the aphids were found in the blossoms, on the flower buds and at the bases of the leaf stalks.

The figures show that the sprinkling method, with a treatment in January, produces a better and longer effect than the dipping method. "Systox" was more effective than "Schradan". On plants sprinkled with "Schradan", the numbers of aphids increased during the first fourteen days following the treatment. 30 ccs. of 0·1 % "Systox" produced an effect just as good and lasting just as long as when 50 ccs. were applied per pot. "Systox" proved to be fully effective four days after a treatment in which the plants were dipped. This

*Table 11.* Spray and sprinkling tests with systemic phospho

| | Preparation | % Concentration | 4 days | 7 days | 10 days | 14 days | 16 days | Effec<br>I<br>da |
|---|---|---|---|---|---|---|---|---|
| Test XII, *Senecio cruentus* | Dipping 9 January | | | | | | | |
| | "Schradan 3" | 0·125 | 52·0 | 68·0 | 75·0 | 73·0 | | 7 |
| | "Systox" | 0·05 | 98·0 | 100 | [1] 100 | [2] 100 | | 7 |
| | [1] Plants infected with 39 aphids<br>[2] Plants infected with 80 aphids | | | | | | | |
| | Sprinkling 9 January, 50 ccs of wash per pot (11 ccs) | | | | | | | |
| | "Schradan 3" | 0·125 | 0 | 0 | 0 | 0 | | 5 |
| | "Systox" | 0·1 | 5·0 | 97·0 | [1] 100 | [2] 100 | | 10 |
| | [1] Plants infected with 34 aphids<br>[2] Plants infected with 60 aphids<br>[3] Plants infected with 60 aphids | | | | | | | |
| | Sprinkling 9 January, 30 ccs of wash per pot (11 ccs) | | | | | | | |
| | "Schradan 3" | 0·125 | 0 | 0 | 0 | 0 | | 3 |
| | "Systox" | 0·1 | 5·0 | 100 | [1] 100 | [2] 100 | | 10 |
| | [1] Plants infected with 31 aphids<br>[2] Plants infected with 60 aphids | | | | | | | |
| Test XIII, Cyclamen (*Cyclamen pers. c.*) | Spraying 18 January | | | | | | | |
| | Bis(isopropylamido)-fluorophosphate | 0·1 | 100 | | 100 | | [1] 99·8 | |
| | "Schradan 3" | 0·1 | 99·7 | | 100 | | [2] 100 | |
| | "Systox" | 0·05 | | | 100 | | [3] 100 | |
| | [1] Plants infected with 40 aphids<br>[2] Plants infected with 40 aphids<br>[3] Plants infected with 40 aphids<br>[4] Plants infected with 60 aphids | | | | | | | |
| | Sprinkling 18 March, 70 ccs of wash per pot (14 ccs) | | | | | | | |
| | Bis(isopropylamido)-fluorophosphate | 0·2 | 98·8 | | 99·7 | | [4] 100 | |
| | "Schradan 3" | 0·2 | 55·6 | | 94·3 | | 97·8 | |
| | "Systox" | 0·1 | [1] 99·8 | | [2] 100 | | [3] 100 | |
| | [1] Plants infected with 200 aphids<br>[2] Plants infected with 90 aphids<br>[3] Plants infected with 110 aphids<br>[4] Plants infected with 55 aphids<br>[5] Plants infected with 150 aphids<br>[6] Plants infected with 90 aphids | | | | | | | |

rations against aphids (*Aphididae*), 1950—1952.

| r | 25 days | 29 days | 32 days | 36 days | 40 days | Remarks |
|---|---|---|---|---|---|---|
| )<br>5 | 0<br>72·5 | | 0<br>5·0 | 0 | | 5 plants per test row. Approx. 320 and 280 aphids per 5 plants before the treatment. |
| )<br> | 75·0<br>75·0 | | 80·0<br>100 | 0<br>100 | <br>100 | 5 plants per test row. Approx. 500 and 350 aphids per 5 plants before treatment. Renewed sprinkling with 0·2% "Schradan 3" 3 and 13 days following first application |
| 0<br> | 70·0<br>99·0 | | 55·0<br>100 | <br>99·0 | <br>100 | 5 plants per test row. Approx. 580 and 300 aphids per 5 plants before treatment. Renewed sprinkling with 0·2 % "Schradan 3" 14 days following first treatment. |
| 5<br>5 | <br>[4] | 70·0<br>72·5<br>100 | | | | 5 plants per test row. Approx. 450—700 and 700 aphids per 5 plants prior to carrying out treatment. |
| ·0<br>·1 | 78·0<br>[5] 99·0 | <br>99·1<br>[6] 99·0 | | 80·0<br><br>98·0 | | 5 plants per test row. 400—700 and 700 aphids per 5 plants before the application. On untreated, 550 aphids per 5 plants. |

effect was not produced until after a week in the sprinkling test. This means that the absorption and translocation processes last longer in January than in the months of Spring.

Plants treated by the sprinkling method were colonized with aphids after 10 and 14 days respectively, and within four days the aphids were exterminated. Other plants also treated by the sprinkling method were not colonized with aphids until after 22 days. In this case it took 10 days before all the aphids were killed. It is, therefore, evident from these figures that a single treatment with "Systox" by means of the sprinkling method produces an effect lasting at least six weeks. A single dip, however, produces an effect lasting only two weeks.

"Schradan 3" applied in January did not produce a satisfactory effect either as a dip or when applied by sprinkling. This only goes to support the theory that the effect of the "Schradan" preparations is largely dependent upon the vigorous growth of the plants, added to which the days must be long and bright.

Test XIII (Table 11), carried out in March, shows that "Schradan" has a far better effect. Despite this, however, a more reliable and longer effect was obtained with "Systox", both as a spray and when applied by sprinkling, than with either "Schradan 3" or bis(isopropylamido)fluorophosphate. On plums colonized with aphids 16 days following the treatment, a full effect was obtained with "Systox" in less than six days. Bis(isopropylamido)fluorophosphate and "Schradan 3", when applied by spraying, remain effective for two weeks whereas "Systox" is effective for three weeks. When the sprinkling method was applied, it was established that bis(isopropylamido)fluorophosphate was effective for two weeks and "Schradan 3" for four weeks. "Systox" when applied by sprinkling had an effect lasting five weeks.

*Table 12.* Tests with systemic phosphorus preparations against grape mealybugs (*Pseudococcus maritimus* Ehrh.) occurring on Fuchsia, 1951.

| | Preparation | % Concentration | Date of treatment | Approx. effect in % after 4 days | 10 days | 16 days | 21 days | Remarks |
|---|---|---|---|---|---|---|---|---|
| Test XIV, Bestun | Spraying | | | | | | | |
| | "Schradan 3" | 0·1 | 27 Aug. | 25 | 65 | 32 | 38 | On untreated plants, 19, 7, 5 and 20 grape mealybug colonies per plant. 100 ccs of wash sprinkled per pot (12 cm). |
| | "Schradan 3" | 0·1 | 27 Aug. and 6 Sept. | 50 | 65 | 75 | 80 | |
| | "Systox" | 0·05 | 27 Aug. | 80 | 90 | 99 | 99 | |
| | "Systox" | 0·05 | 27 Aug. and 6 Sept. | 77 | 99 | 100 | 100 | |
| | Pouring | | | | | | | |
| | "Schradan 3" | 0·125 | 27 Aug. | 0 | 33 | 66 | 33 | |
| | "Schradan 3" | 0·125 | 27 Aug. and 6 Sept. | 0 | 19 | 25 | 19 | |
| | "Systox" | 0·1 | 27 Aug. | 0 | 16 | 56 | 52 | |
| | "Systox" | 0·1 | 27 Aug. and 6 Sept. | 0 | 31 | 74 | 88 | |

Casida et al. (1952) made the discovery that the effect of "Schradan" is reduced when it is applied by sprinkling on soil containing a large amount of phosphorus, it being probable that this type of soil to a certain extent hinders the absorption of the preparation through the roots. This fact was not observed, however, when the plants were sprayed with "Schradan".

Table 12 shows that "Systox" has a better effect than "Schradan" against grape mealybugs (*Pseudococcus maritimus* Ehrh.). Spraying proved to be a more reliable method than sprinkling, and two treatments produced a better effect than only one.

In one test against *Pseudococcus maritimus* Ehrh. on *Aphelandra squarrosa*, the immersion of the plants on June 8 and 22 proved to be most effective. In the last check made on July 18, it was found that all the grape mealybugs had been killed following an application of "Systox", whereas with "Schradan 3" only 50 % were exterminated.

From Table 13 it is seen that a control of scales (*Lecanium hesperidum* L.) carried out in Winter is not sufficiently effective when the preparation is applied by sprinkling. Three applications of both preparations by sprinkling led to heavy leaf fall. Dipping the plants in "Systox" admittedly proved effective although it was necessary to carry out four treatments at weekly intervals to obtain a really satisfactory result. Leaf injuries were not observed after dipping.

Tests, carried out in 1952 with "Schradan", bis(isopropylamido)fluorophosphate and "Systox" against violet blister mites (*Eriophyes violae* Nal.) occurring on *Viola cornuta* did not produce any satisfactory results. This applied to both single and double treatments, and standard and double concentrations. Allowance should, however, be made for the fact that the Autumn tests were carried out under unfavourable weather conditions.

Sprays with "Schradan" and "Systox" applied in concentrations of 0·1 and 0·5 % produced a good effect after only one treatment against the small chrysanthemum fly (*Phytomyza atricornis* Meig.) and the large chrysanthemum fly (*Phorellia artemisiae* F.) occurring on chrysanthemums. "Systox" was also most effective when applied by the sprinkling method (August 30). Matthysse (1952) reports that "Systox" was also most effective against the larvae of mining flies, and Bosse (1952) writes the same with respect to the larvae of miners.

Unfortunately there was no opportunity to carry out tests on nematodes. Practical tests carried out against stem nematodes (*Ditylenchus dipsaci* Fil.) occurring on *Hydrangea opuloides* show that when "Systox" is applied twice by "pouring", a good effect can be obtained, and in fact the effect is better than that obtained with a thiophosphorus spray. Thiophosphorus, however, was more effective than "Systox" against leaf nematodes (*Aphelenchoides ritzema bosi* Schw. and *Aphelenchoides olesistus* Ritz. Bos.), a fact confirmed by tests carried out in both the U. S. A. and Germany.

In tests carried out on ornamental plants, it was established that both "Schradan" and "Systox" inflicted injuries on *Ixora*. The following ornamental plants on which tests were conducted showed no signs of damage: *Dianthus carioph.*, roses in the greenhouse and outdoors, *Dahlia cult.*, *Chrysanthemum hort.*, *Primula obconica*, *Pelargonium peltatum*, *Senecio cruentus*, *Cyclamen*

*pers. cult., Hydrangea opuloides, Begonia cheimantha, Fuchsia sp., Hedera canariensis variег., Ficus carica, Cystopteris fragilis., Viola cornuta, Zinnia sp., Aphelandra squarrosa* and *Philadelphus sp.*

When growing conditions are normal, and "Schradan" preparations and "Systox" are applied in concentrations of 0·1 % and 0·05 % respectively, the danger of ornamental plants being damaged by the spray is only slight, although this is determined to a certain extent by the number of applications carried out and the intervals between treatments. Tests abroad have shown that "Schradan" and "Systox" can cause injuries to the following plants: *Beloperone, Coleus, Hippeastrum, Senecio cruentus* and *Fuchsia.* The last two plant species did not exhibit any traces of damage in our tests. Johansen (1952) reports that ornamental plants tend to be easily susceptible to spray injuries when growing outdoors in a soil with a low nitrate content.

*Table 13.* Dipping and sprinkling tests with systemic phosphorus preparations against scale insects *(Lecanium hesperidum* L.), 1950—1952.

| Test No- | Pre-paration | % Concen-tration | Approx. effect in % after 7 days | 14 days | 23 days | 28 days | 35 days | Remarks |
|---|---|---|---|---|---|---|---|---|
| XV Lille-aker | *Hedera canariensis varig.* Dipping on June 8 and 22 | | | | | | | 5 plants per test row, % of killed scale insects applies to both larvae and juvenile scales. Approx. 50 % of the older scales were killed by "Systox" on untreated plants; there were on the average 70 larvae and 40 adult scales per plant. |
| | "Schra-dan 3" | 0·1 | | 8 | | 25 | | |
| | "Systox" | 0·05 | | 75 | | 85 | | |
| XVI Toyen | *Cystopteris fragilis* Dipping on April 7, 14, 21 and 28 | | | | | | | Heavy pre-treatment infestation. The scale insect species occurring in this test was *Lecanium hemisphaericum* Targ. |
| | "Systox" | 0·05 | 25 | 65 | 95 | | | |
| XVII Lille-aker | *Ixora hybr. Fraseri* Sprinkling on February 6 | | | | | | | 50 ccs of wash were sprinkled per plant (9 cm pot). 5 plants per test row. On untreated plants, 81 living scales were found on February 6, and 264 28 days later. |
| | "Schra-dan 3" | 0·2 | 0 | 25·7 | 40·6 | 31·9 | | |
| | "Systox" | 0·1 | 0 | 28·7 | 25·9 | 34·3 | | |
| | Sprinkling on February 6, 13 and 28 | | | | | | | |
| | "Schra-dan 3" | 0·2 | 0 | 23·1 | 24·1 | 27·9 | | |
| | "Systox" | 0·1 | 0 | 12·6 | 24·9 | 44,7 | | |
| | "Systox" | 0·2 | 0 | 21·8 | 36·0 | 41·2 | | |
| | Dipping on February 6, 13 and 28, and on March 6 | | | | | | | |
| | "Systox" | 0·05 | 0 | 27·8 | 72·9 | 88·9 | 99·5 | |

### Cereals

In 1952 *Aphis padi* L. inflicted heavy damage on oats. Controls carried out with nicotine sulphate and thiophosphorus did not produce an adequate effect. Tests with "Systox", however, showed that it is possible to obtain a rapid and good effect against this pest. Comparative tests with 40 and 25 ccs of "Systox" per dekar, mixed with 40 to 80 l of water, showed that a solution of 25 cc to 40 l of water per dekar was fully effective. Even 12·5 cc per dekar produced a good effect within the short period of 24 hours. The sprays were carried out in the first part of July on plants approx. 0·5 m tall.

10 cows were put out in the early evening to graze on an oat field freshly sprayed with "Systox", and left there overnight. The veterinary surgeon who was called in to examine the animals, found that no harm whatsoever had been caused by consuming the sprayed crop. Moreover the amount of milk given by the cows did not decrease during the following days.

## Summary

This paper has been confined to giving a survey of the systemic preparations of the "Schradan" group, bis(isopropylamido)fluorophosphate and "Systox", together with details about absorption and translocation in the plants, the systemic mode of action and the toxicity of these preparations to humans and animals.

### *Tests with systemic preparations*

#### Fruit trees

The tests carried out from 1950 to 1952 together with the practical tests carried out on 15,000 to 20,000 trees in 1952 show that "Systox" has a more reliable effect than the "Schradan" preparations, particularly when a certain amount of time is allowed to elapse following the blossom period before the sprays are applied.

Under the weather conditions prevailing in 1952, the test results against *Paratetranychus pilosus* were obtained by pre-blossom and post-blossom sprays. In the case of aphids it was found that the best results were to be obtained with a pre-blossom spray. Both "Schradan" and "Systox" remained effective for a much longer period against aphids than nicotine sulphate. Even against wax-covered aphids, the results were far better. "Systox" proved to be more effective than "Schradan" when used against *Yezabura malifolii* Fitch., *Yezabura devecta* Walk. and *Hyalopterus arundinis* Fab. which are all covered with wax, whereas against *Aphis pomi* Deg. and *Aphis pruni* Re. and *Paratetranychus pilosus* there was little to differ between the two preparations. The effect of "Schradan" did not persist so long although it was best when the sprays were carried out before and after the blossom. With respect to "Systox" it should be mentioned that a strong wind blowing during spraying apparently impairs the effect.

It was found that on the average useful predators and parasites are not harmed by systemic preparations. It might be said that hardly any spray damage is caused by these preparations.

In fruit growing, "Schradan" and "Systox" are of economic significance only against mites and aphids.

### Berries

On strawberries, two sprays with systemic preparations applied between leaf formation and blossom against *Tetranychus sp.* produce a better and much longer effect than when thiophosphorus preparations are used.

### Ornamental plants outdoors and in the greenhouse

The tests show that a high degree of success can be achieved by applying "Schradan" preparations in summer against mites and aphids. "Systox" also proved to be most effective against stem nematodes, woolly aphids and the larvae of scale insects, irrespective of whether the control measures are carried out in summer or in winter. When the sprays are carried out in summer, the effect of "Schradan" and "Systox" persists for 2 to 3 weeks. In one case an effect lasting 5 to 6 weeks was observed on potted flowers which had been treated by the sprinkling method. In winter the effect lasts longer than in summer.

The efficacy of systemic preparations depends upon a number of factors. For example the relative humidity should not be too high, and the plants themselves must be dry. The effect is best at high temperatures, when the days are long, and there is bright sunshine. The plant species and the age of the plants also play a great part. Absorption and translocation proceed quickest in young plants which are growing vigorously. It is commendable to carry out treatments in the morning. "Schradan" is far more dependent upon the above-mentioned factors than "Systox". After plants have been sprinkled with systemic preparations, the concentration in the plant does not reach its maximum until a week later. In view of the fact, however, that the type of soil, age of the plants, the plant species, and the way the plants live all exert an influence upon absorbability, it may under certain circumstances take weeks in the case of trees before the concentration reaches its maximum.

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In Norway the systemic preparations "Schradan 3", "Schradan 2" and "Systox" were approved in 1953 for application on fruit trees, berries, ornamental plants in greenhouses and outdoors, and on cereals. In the case of apples and pears the preparations can be used up to the second post-blossom spray, and with respect to cherries, plums and berries up to the first post-blossom spray. The preparations can be used on strawberries up to the last pre-blossom spray. Cereals may only be treated with systemic preparations up to the shoot stage. It is prohibited to apply systemic preparations on root crops and vegetables growing outdoors and under glass. It is also forbidden to grow plants in greenhouses for human consumption on soils which have been "watered" with systemic preparations.

Since systemic preparations are very toxic to humans and domestic animals, care should be taken when spraying that the concentration does not come into contact with the skin and that the spray mist is not inhaled. Therefore it is essential to wear respirators or goggles, protective clothing and rubber gloves when working with these preparations. On warm days it is advisable to carry out spraying in the evening. Protective clothing and respirators must also be worn when spraying in greenhouses.

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# The Influence of "SYSTOX" upon Microorganisms

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The systemic insecticide, "Systox" (8169), which was developed by Schrader, can be used either as a dip, a spray or as "pouring" agent (Untersten-höfer), thanks to its excellent stability and its good translocation in the plant.

In view of its many possibilities of application, it appeared expedient to carry out studies on the toxicity of the insecticide to microorganisms in the soil. A reduction of microflora lasting over a long period or a displacement of the biological balance in favour of certain species might under certain circumstances — direct or as the result of a change in the fertility of the soil — have an effect upon tall plants.

To clarify these questions, the influence of "Systox" was tested upon 60 different soil organisms in vitro, these being classified in three groups, namely bacteria which constitute the majority of the soil flora, actinomycetaceæ which play a decisive part in metabolism, and fungi among which mould and yeasts predominate in garden soils.

## Method

Difficulties are encountered when carrying out microbiological work with "Systox" due to the sensitivity of the preparation to heat. The insecticide is inactivated at the temperatures used in the sterilisation of the nutrient medium. An attempt to surmount these difficulties and to degerminate the prepared solution of insecticide and bouillon by means of filtration miscarried in that the insecticide did not completely pass through degermination layers of the membrane filter. When the concentration of a 0·01 % emulsion of "Systox" was tested with *Drosophila melanogaster* before and after filtration, the period of toxic action increased three-fold. There was, therefore, no alternative but to dilute the insecticide sterile, and to pipette it into each specimen separately after sterilizing the nutrient medium.

Some of the microorganisms used (see Table 1) were isolated straight from the soil, and the formulation of the question did not require an exact determination of the strains. The fungi were cultivated in a solution of malt-extract (1000 g water, 40 g biomalt, 5 g peptone, pH 5.5—6'), and the actinomycetaceæ and bacteria in bouillon (1000 g water, 3 g Liebig's meat extract, 5 g peptone, 5 g common salt, 12 ccs glycerin, pH: 7).

The effective limit concentrations of the insecticide were determined in Erlenmeyer flasks (100 ccs) containing 20 ccs of nutrient solution. The concentration was graduated in such a manner that each stage formed a geometrical progression with 2 as its radix: $2^0$, $2^{-1}$ etc. to $2^{-10}$. 5 days after the start of the test, the mycelium was dried, in accordance with Allen's specification, for 12 to 14 hours at 70 °C and for 2 hours at 150 °C, and weighed on the analytical balance. Since it was established that the differences could be determined by estimating the growth just as well as by determining the dry weight of the mycelium, only the growth was estimated in the subsequent experiments.

The resistance of the microorganisms to "Systox" was tested in test tubes containing 10 ccs of nutrient solution. These were injected with material of 24 hour old slant agar cultures, incubated at 28 °C, and evaluated at various intervals.

Einhorn's fermentation tubes, which after being sterilized were filled with malt extract solutions containing various concentrations of insecticide and injected with yeast Frohberg, were used to carry out the fermentation tests. The respiration of sugar was then measured quantitatively from the volumes of carbon dioxide formed.

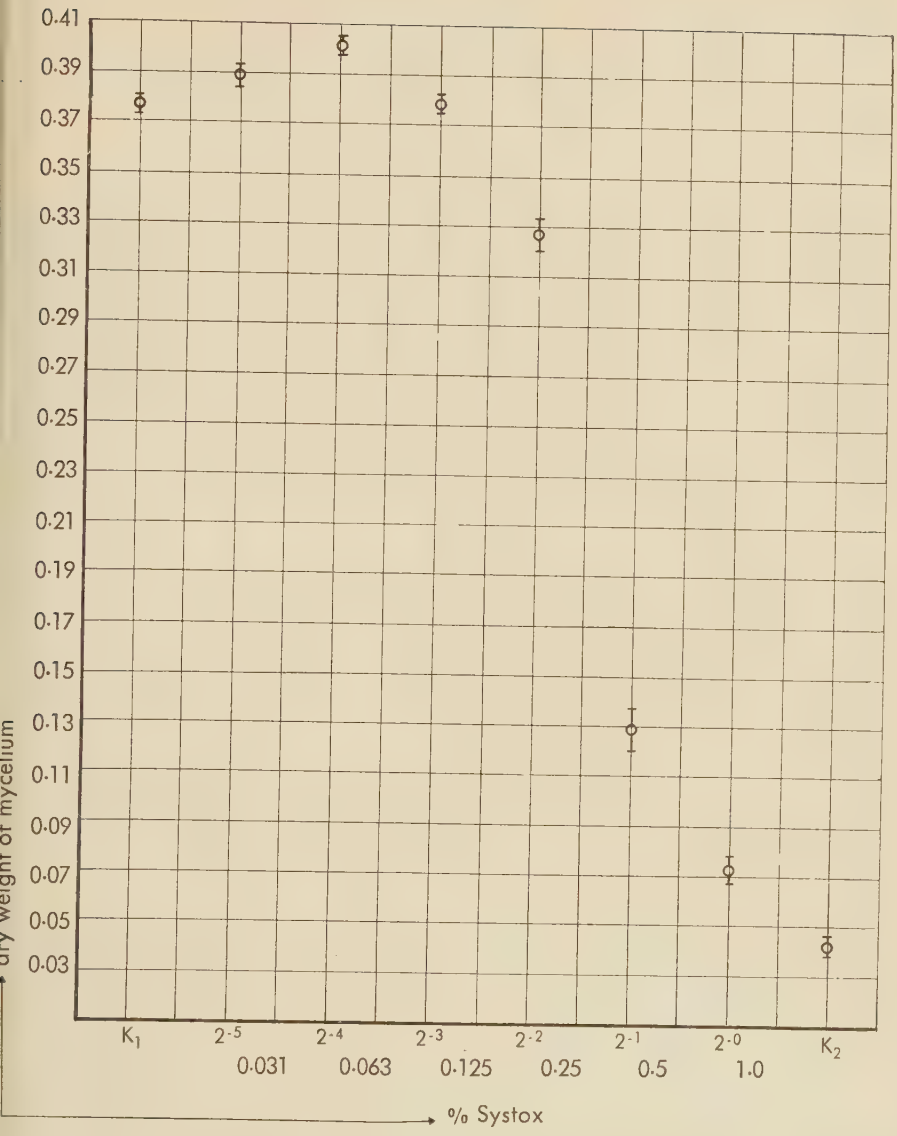


Fig. 1: Influence of various concentrations of "Systox" upon the development of *Aspergillus niger* 5 days after the start of the test.
Abscissa divided logarithmically: concentrations of "Systox" in %; $K_1$ = injected checks without "Systox"; $K_2$ = non-injected checks without "Systox"; Ordinate divided arithmetically: dry weight of mycelium in g; n = 4.

To estimate the statistical reliability of the measurements the P values were taken from P ä t a u ' s table with the aid of the degrees of freedom $(n_1+n_2-2)$ and the calculated t-values.

$$(t = \frac{M_1 - M_2}{m_D};\ m_D = \sqrt{m_1^2+m_2^2});\ m = \pm\sqrt{\frac{\Sigma x^2 - M \Sigma x}{n(n-1)}})$$

A difference can be accepted as reliable when P is less than 0·27%.

## Test results

To determine the extreme concentration limits of the insecticide for microorganisms (initial inhibition and complete inhibition), *Aspergillus niger* was cultivated in increasing concentrations of "Systox".

In the strongest dilutions (0·03125 to 0·00098 % "Systox"), the preparation has no influence upon *Aspergillus*. The values of the dry weights agree with those of the checks without "Systox" ($K_1$), and therefore they are not shown. From Fig. 1 it is seen that the fungus is at first stimulated by a slight dosage of poison (0·0625 %), the average value of the dry weights amounting to 0·4005±0·00317, that of the checks without "Systox" to 0·3767±0·00313; P=0·18 %. The difference between these values, therefore, is extremely reliable, a confirmation of previous observations with *Aspergillus niger* and *Cladosporium* which also led to the assumption that slight concentrations of "Systox" have a stimulating effect.

Whereas the values of the next concentration (0·125 % "Systox") were again equal to the checks, the insecticide exerted a pronounced inhibiting influence at a concentration of 0·25 % and above. The dry weight of the mycelium grown in 0·5 % "Systox" amounted to only one-third of the check. In the 1 % emulsion, it was just possible to detect growth, without spore formation, on the sides of the vessel; the development was already so weak that the values of this series could not be regarded as being particularly reliable in comparison with the non-injected check ($K_2$) (P = 0·3 %).

The formulation of the question required that the studies be extended to a large number of soil organisms. Consequently 60 different species were cultivated in the limit concentrations determined in order to establish whether growth is generally inhibited in a concentration of approximately 0·1 % "Systox" and upwards, and completely stopped at a concentration of about 1 % and above.

Table 1 shows that all the strains examined grow in a concentration of 0·1 % "Systox". Admittedly the growth of many strains is somewhat slight in comparison with the checks not containing "Systox", particularly with respect to the actinomycetaceæ and cocci, although it does not cease completely. This time, *Aspergillus niger* was also considerably inhibited in a 0·1 % emulsion of "Systox". Furthermore, it should be pointed out that the majority of the strains examined lagged somewhat behind the checks even in a concentration of 0·01 % but this was made up for during the course of development.

In an emulsion of 1 % "Systox", none of the examined fungi and actinomycetaceæ developed. In order to establish whether the fungi were killed or whether their development was merely inhibited, *Rhodotorula glutinis* and yeast F r o h b e r g were kept for 10 days in 1 % "Systox" and then injected into malt extract agar, with the result that yeast F r o h b e r g developed, whereas *Rhodotorula* did not. *Cunninghamella elegans* and *Oidium lactis* also stopped growing after being kept for four weeks in 1 % "Systox".

*Table 1:* Growth of fungi, actinomycetaceæ and bacteria in nutrient solutions of different concentrations of "Systox".

Evaluation 12 days after start of test: 0 = no growth; 1 = very weak growth; 2 = weak; 3 = good; 4 = very good; + = contamination.

| Strain | Checks without "Systox" | | | 0·1 % "Systox" | | | 1 % "Systox" | | |
|---|---|---|---|---|---|---|---|---|---|
| *Mucor mucedo* | 4 | 4 | 4 | 1 | 3 | 3 | 0 | 0 | 0 |
| *Absidia spinosa* | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| *Cunninghamella elegans* | 4 | 4 | 4 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Rhizopus nigricans* | 4 | 4 | 4 | 2 | + | + | 0 | 0 | 0 |
| *Phycomyces blacesleeanus* | 2 | 2 | 4 | 3 | 3 | 3 | 0 | 0 | 0 |
| *Aspergillus niger* | 4 | 4 | 4 | 2 | 3 | 3 | 0 | 0 | 0 |
| *Aspergillus oryzae* | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| *Penicillium notatum* | 4 | 4 | 4 | 1 | 2 | 3 | 0 | 0 | 0 |
| *Penicillium candidum* | 4 | 4 | 4 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Penicillium* | 4 | 4 | 4 | 3 | 3 | + | 0 | 0 | 0 |
| *Oidium lactis* | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| *Cladosporium 1* | 2 | 4 | 4 | 2 | 2 | + | 0 | 0 | 0 |
| *Cladosporium 2* | 2 | 4 | 4 | 2 | 2 | 3 | 0 | 0 | 0 |
| *Alternaria* | 4 | 4 | + | 3 | 0 | + | 0 | 0 | 0 |
| *Fusarium* | 4 | 4 | 4 | 3 | 3 | 3 | 0 | 0 | 0 |
| unclassified fungus, strain 1 | 4 | 4 | 4 | 2 | 2 | 2 | 0 | 0 | 0 |
| unclassified fungus, strain 2 | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| unclassified fungus, strain 3 | 3 | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 |
| unclassified fungus, strain 4 | 4 | 4 | 4 | 3 | 3 | 3 | 0 | 0 | 0 |
| Soor | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| *Mycoderma valida* | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| yeast Frohberg | 4 | 4 | 4 | 2 | 2 | 3 | 0 | 0 | 0 |
| *Rhodotorula glutinis* | 4 | 4 | 4 | 1 | 2 | 2 | 0 | 0 | 0 |
| *Torulopsis lipofera* | 4 | 4 | 4 | 2 | + | + | 0 | 0 | 0 |
| yeast 1 | 4 | 4 | 4 | 2 | 2 | 3 | 0 | 0 | 0 |
| yeast 2 | 4 | 4 | 4 | 2 | 2 | 3 | 0 | 0 | 0 |
| *Streptomyces 1* | 1 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Streptomyces 2* | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Streptomyces 3* | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Streptomyces 4* | 3 | 3 | 3 | 1 | 2 | 3 | 0 | 0 | 0 |
| *Streptomyces 5* | 4 | 4 | 4 | 1 | 2 | 2 | 0 | 0 | 0 |
| *Streptomyces 6* | 4 | 4 | 4 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Streptomyces 7* | 4 | 4 | 4 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Streptomyces 8* | 4 | 4 | 4 | 1 | 1 | + | 0 | 0 | 0 |
| *Streptomyces 9* | 4 | 4 | 4 | 3 | 3 | 3 | 0 | 0 | 0 |
| *Proactinomyces flavus* | 4 | 4 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| *Proactinomyces coralleus* | 4 | 4 | 4 | 2 | + | + | 0 | 0 | 0 |
| *Proactinomyces ruber 6* | 4 | 4 | 4 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Proactinomyces ruber 30* | 4 | 4 | 4 | 2 | + | + | 0 | 0 | 0 |

| Strain | Checks without "Systox" | | | 0·1 % "Systox" | | | 1 % "Systox" | | |
|---|---|---|---|---|---|---|---|---|---|
| *Mycobacterium phlei* . . . | 4 | 4 | + | 1 | 0 | 0 | 0 | 0 | 0 |
| *Mycobacterium luteum* . . | 4 | 4 | 4 | 1 | 1 | 0 | 0 | 0 | 0 |
| *Mycobacterium* . . . . . | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Coccus 1* . . . . . | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Coccus 2* . . . . . | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Staphylococcus aureus* . . . | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Sarcina lutea* . . . . . | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Bacterium coli* . . . . . | 3 | 3 | 3 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Bacterium prodigiosum* . . | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| *Bacterium 1* . . . . . | 3 | 3 | 3 | 1 | 1 | + | 0 | 0 | 0 |
| *Bacterium 2* . . . . . | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 0 |
| *Bacterium 3* . . . . . | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 |
| *Bacterium 4* . . . . . | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| *Bacterium 5* . . . . . | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| *Pseudomonas juglandis* . . | 4 | 4 | 4 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Pseudomonas fluorescens* . | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 |
| *Pseudomonas pyocyanea* . . | 4 | 4 | 4 | 3 | 3 | 4 | 4 | 4 | 4 |
| *Bacillus mycoides* . . . . . | 3 | 3 | 3 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Bacillus mesentericus* . . . | 3 | 3 | 3 | 2 | 2 | 2 | 0 | 0 | 0 |
| *Bacillus subtilis* . . . . . | 3 | 3 | 3 | 1 | 2 | 2 | 0 | 0 | 0 |
| *Bacillus amylobacter* . . . | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 |

Whereas the development of most bacteria was also inhibited by a 1 % concentration of insecticide, all the examined strains, which discharge a water-soluble, fluorescent dyestuff grew surprisingly well in this concentration, namely *Pseudomonas fluorescens, Ps. pyocyanea,* as well as two bacteria isolated from soil. In addition to these, *B. prodigiosum,* which discharges a dyestuff soluble in alcohol, also proved to be resistant. Since the possibility could not be disregarded that the excellent compatibility of these bacteria (cultivated in neutral bouillon) with "Systox", as compared with the poor compatibility of fungi (cultivated in sour malt extract solution), might have been due to the cultivation in different nutrient media, *Ps. pyocyanea* and *B. prodigiosum* were also cultivated in sour bouillon (pH: 4) and in a malt extract solution which were both adjusted to a concentration of 1 % "Systox". Since growth was established in all the specimens, any influence of the nutrient medium upon the compatibility with "Systox" was eliminated.

Since "Systox" (8169) is composed of equal parts of active ingredient (E 1059) and emulsifier (233), a test was carried out to determine whether the toxic effect of high concentrations of "Systox" is due solely to the active ingredient or also to the emulsifier. The toxic action of these substance was calculated from the influence of yeast F r o h b e r g upon the functional metabolism.

As seen from Table 2, the fermentation is most favourable in the check without "Systox" and in the pure emulsifier solution. The active ingredient inhibits the $CO_2$ development, and "Systox" prevents it almost completely at the

given time (3 days later, the fermentation in these specimens is also completed). Therefore, the influence of the active ingredient in the corresponding concentration (0·1 % "Systox" corresponds to 0·05 % active ingredient) is considerably weaker than that of "Systox". This phenomenon, which was also observed with *Ps. pyocyanea*, is evidently to be attributed to the fact that the active ingredient which is slightly soluble in water, is not finely distributed until the emulsifier is added (Schrader), so that it therefore has a stronger action in the emulsion.

Further, the influence of 0·1 % emulsions of "Systox" and "E 605" on *Aspergillus oryzae* was investigated comparatively. The evaluation of growth (see Table 1) produced an average value of 2·0 ± 0·26 for "Systox" and 3·4 ± 0·25 for "E 605" (P = 0·35 %), five days after the test was started. This test showed, just as in the preliminary tests with *Ps. pyocyanea*, that the growth is inhibited somewhat more strongly by "Systox" than by "E 605". The difference, however, had been fully cancelled out by the 19th day when the second evaluation was made.

*Table 2:* Fermentation of sugar of malt extract solution of different insecticide concentrations by yeast Frohberg 29 hours after the start of the test (2 parallels).

| Insecticide | % sugar | |
|---|---|---|
| check, without . . . . . | 1·02 | 0·85 |
| 0·5 % emulsifier 233 . . . . . | 1·12 | 1·09 |
| 0·05 % active ingredient E 1059 . . | 0·45 | 0·50 |
| 0·1 % "Systox" 8169 . . . . . | 0·25 | 0·00 |

## Summary

In the above tests, a large number of microorganisms were tested for their resistance to "Systox" in order to draw general conclusions about the influence exerted by the insecticide upon the soil flora. Considering the large number of strains involved, it was decided not to determine exactly the limit concentrations at which injuries are inflicted for the individual organisms, especially as such investigations in vitro cannot be applied precisely to conditions in the soil.

It was shown that the development of microorganisms is inhibited by high concentrations of "Systox", and that this effect is caused exclusively by the active ingredient and not by the emulsifier. "Folidol-E 605" revealed a somewhat slighter toxicity than "Systox".

Most of the microorganisms were unable to continue development in a 1 % emulsion of "Systox". Only a few bacteria were able to grow in this concentration to the same extent as those in the checks without "Systox". The eradication limit for all strains, with the exception of these bacteria, was between 1 % and 0·1 % concentrations of "Systox". A 0·1 % emulsion inhibited the development of many strains but did not cause it to cease. The lower transition concentrations — between the toxic effective dose and the ineffective dose of poison — even stimulated the growth of some strains.

The values of the concentrations used in the field are generally between 0·1 % and 0·001 % "Systox" (Bosse, Unterstenhöfer). The toxicity of a 0·1 % emulsion which in vitro is already very weak will be even weaker in

the soil since the concentration of "Systox" is constantly reduced by evaporation and absorption. Further, when a toxic effect decreases, the original number of microorganisms is generally readjusted very rapidly (Waksman and Starkey). Therefore, "Systox" applied by sprinkling at a concentration of 0·1 % and below will not perceptibly affect the soil organisms, especially as a 0·05 % emulsion is mostly used, the concentration which has a stimulating effect.

It can be said from the results obtained that the limit at which the insecticide is harmful to microorganisms more or less corresponds with the limit for those tall plants which are particularly compatible with "Systox" (Untersten-höfer). The concentrations used in the field are generally under this limit. Disregarding the possibility that individual groups of microorganisms are far more sensitive than the 60 strains examined, one might be justified in concluding that microbiologically there can be no misgivings as to the application of "Systox".

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# Attempt at Simultaneous Control of Thrips and Larch Casebearers, Its Fundamental Principles and Prospects


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In the cultivated regions of Central Europe, the European larch is frequently infested in the critical stage of its two youngest age classes by larch thrips and larch casebearers, two extremely troublesome pests which occur simultaneously. Compared with the other harmful insects infesting the larch, which chiefly occur as secondary pests or which tend to keep their mass reproductions local, graduations of the casebearer moth and the thrips are uncommonly widespread, and bear a chronic character in many regions. The frequent occurrence of both pests in the same stocks has in the last few years raised the question as to the possibility of carrying out a joint control. The problem encountered was that the two pests were found to evade each other both tempo-

rally and spatially in order to satisfy their own specific requirements, and consequently a joint control along the lines of past methods appeared impossible (Thalenhorst, 1953). The *thrips* colonize the top shoots of the larch in May, at a time when the casebearer larvae have stopped feeding in the centre and lower regions of the crown, and seek protection under a thick cocoon where they can pupate. Moreover, the majority of the thrips continue to migrate from the larch tree until the beginning of August, just as the barely detectable boring activities of the young casebearer larvae have begun.

From the very outset, however, we are faced with the question as to whether there is any purpose in carrying out a control. Both insects inflict damage to an extent which is difficult to assess because it is covered up by symptoms of regeneration. Just the same, the opinion is held nowadays that serious damage caused by thrips in mixed stands must be combatted if the larches growing in these stands are to be preserved. With the exception of local occurrences there is, however, widespread doubt as to whether there is any necessity for a control of casebearers.

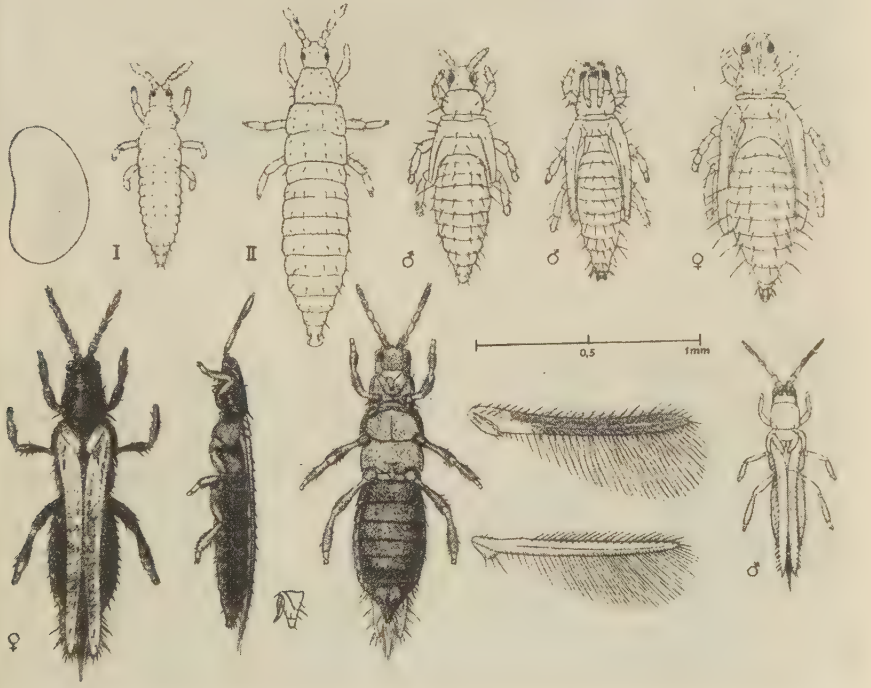


Fig. 1: Different stages in the development of the larch thrips (*Taeniothrips laricivorus* KRAT.): Egg, first and second larval stages, male prepupa and pupa, female pupa, female (dorsal), female (dormant form, lateral and ventral), the dull fore wing and the hyaline hind wing in the distal sections, male.

## I. Facts about the pests

The larch thrips (*Taeniothrips laricivorus* KRAT.), known since 1926 as a pest originating in Czechoslovakia, but which actually was first discovered and described in 1941, today occurs over an area ranging from Denmark to the north of Yugoslavia, Italy and Switzerland. It causes serious damage chiefly in Lower Saxony, Westphalia and Hessen, in North Baden and around Lake Constance, and also in the northern parts of Lower Austria.

| | Features of infestation | |
|---|---|---|
| | on European larches | on spruces |
| April/May | Individual sucking females in the dwarf shoot clusters, later in the newly formed long shoots at the top of the tree. | Rapid decrease in overwintered female population, later individual females on young top shoots. |
| End of May/ June | Females and larvae, later males too, at the tips of the young long top shoots on which deformations of the needles ("needle bristling"), resin flow and transverse shakes increase. | Individual imagoes and larvae on the young long shoots provided these have a thick covering of needles and have a soft membrane. |
| July | Many imagoes and larvae on the strongest long shoots; marked deformation of the needles and formation of transverse shakes on the shoot; shoot tips start to die off and turn brown. | Individual imagoes and larvae on the shoot and terminal buds, particularly on Sitka spruces. Often more males than females. Less formation of transverse shakes on the shoot bark. |
| August/ September | Following a decrease in the larval population, also reduction in the numbers of imagoes, particularly the males. Early lignification of damaged shoot parts and formation of healthy, green needle clusters at the end of the less seriously damaged shoots or new shoots (Fig. 10). | Increase in numbers of imagoes, later only females on vigorously growing terminal buds and particularly under the previous year's bract on open crown parts. |
| October/ beginning of April | Evident transverse shake formation on shoots which have in the meantime become woody, and on which the remainders of deformed needles are often found clinging to the damaged parts. Clearly visible changes in the tree-top structure by the formation of new shoots, such as formation of bayonet-shaped tops and fork tops. | Overwintering females under the bract at the base of the outer shoots. |

Biology: About two weeks after the leaves have started growing in the Spring (middle of April to the beginning of May), the hibernated females make their appearance on the larches where they feed for a brief period, and then deposit about 5 to 7 beanlike eggs, 1/3 mm long, per day in the needles of the top shoots (Fig. 1). Altogether, a female lays about 40 to 50 eggs, particularly on the underside of the basal section of young long shoot needles. The place where the insects — which have a positive photactical reaction and a strongly negative geotactical reaction — prefer to settle is in the end needle cluster of the young, newly developed long shoots at the top of the tree. After 4 to 6 weeks of development (egg 8 to 14, 1st and 2nd larval stages 12 to 16, and pupae 8 to 10 days), the first (Spring) generation begins to fly, mostly around

Fig. 2: Development cycle and damage caused by the larch casebearer *(Coleophora aricella)*; explanation given below.

Fig. 1: Females and old larvae of the larch thrips on a larch shoot.

the middle of June. A few days later the females of this generation revert back to oviposition. Both pupal stages (Fig. 1) are active. Pupation takes place at sites (cracks in the bark, soil) selected by the fully-grown larvae. Consequently pupae are rarely found on the top shoots. The females of the second (Summer) generation — whose imagoes emerge from the middle or the end of June onwards, and whose males die shortly after the copulation — soon begin to colonize their Autumn and Winter quarters. It is from here that they return to the larches again in Spring. The Autumn and Winter hosts for which the larch thrips show greater preference are the spruce and the Sitka spruce on which the insects can also develop in Summer. They live here under the previous year's bract at the base of the outer shoots or in the top buds of young spruces, particularly when these have a luxuriant covering of leaf-shaped needles.

The larch casebearer (*Coleophora laricella* H. B.) was described as long ago as 1816. It thrives on all larch species, and is extremely widespread in the northern hemisphere. In Central Europe the casebearer frequently establishes itself both in natural botanical areas as well as in cultivated areas.

The biology of the casebearer is sufficiently well-known and therefore only a brief outline of its life-cycle will be given (Fig. 2).

The generation is annual and commences with oviposition on the needles at the end of May to the beginning of July (A). The larva which emerges after 8 days, bores into the needle — which is only penetrated by a narrow gallery —

at that point where the egg is clinging to the needle (B). During the course of the late Summer, the larva leaves the needle only to penetrate into another one (C). Finally in Autumn, before the fall of the needles, it migrates enwrapped in the shell of a hollowed-out needle (D) to start its period of hibernation at the base of the dwarf shoot. The favourite hibernation sites of the casebearer are in the dwarf shoot angles of the outer branches and the terminal buds (E) to which the larvae often tightly spin themselves in groups. Single larvae which have either fallen down or unspun themselves from the larches are to be found regularly also in other places, on the trunk, or on soil plants and other woody species.

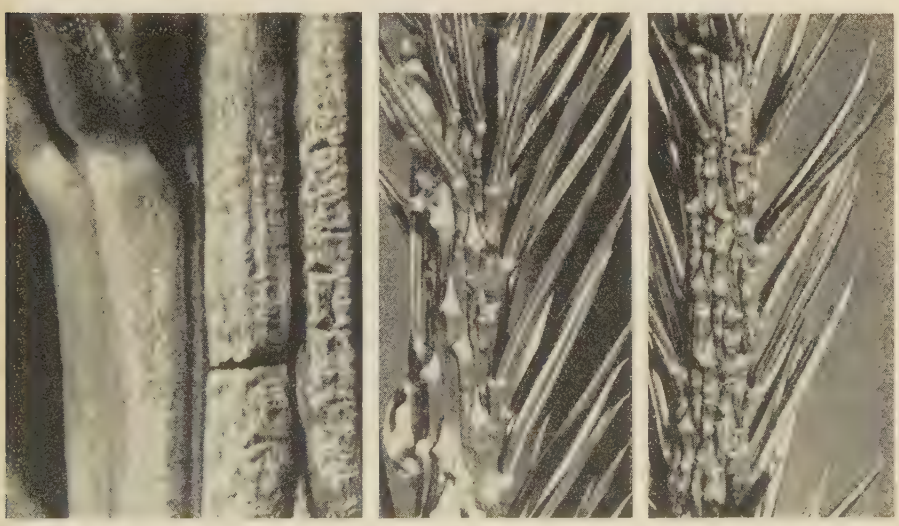

Fig. 3: Damage caused by thrips to the young shoots of the spruce (left) and the Sitka spruce (centre: slight damage; right: serious damage). A characteristic feature of the damage is the formation of transverse shakes.

In Spring, the larvae begin to migrate more or less at the same time as the dwarf shoots start to burst. The larvae feed on the newly developed dwarf shoot needles (F) uninterruptedly for about 4 to 5 weeks without leaving their cocoon which the fully-grown larvae (4th stage) finally extend by attaching a second hollowed-out needle (G). It is in this that the pupation takes place in May. The oviposition of the casebearers, which fly chiefly in June, occurs mostly on the shaded side of the needle. One female deposits anything between 60 and 80 eggs.

## II. The basis for control

### a) Pathogenicity and population ratios

The larch thrips, which is only able to live on the annual long shoots, and which is exclusively a primary insect, chiefly attacks vigorously growing European larches. The Japanese larch is also attacked when it grows in the

vicinity of heavily infested European larches. It is, however, more resistant for various reasons (Vité, 1953). Mass development, therefore, occurs only on European larches which have a persistent and vigorous growth of long shoots i. e. at an age of 8 to 24 (heavier infestation possible at an age of 4—60), and in localities not exposed to the wind, where there is fresh soil. In the stock and on the tree, it is the larches in an advanced stage of growth and the strongest shoots respectively which are heavily infested, in fact to a much greater degree than the subdued larches and the weak shoots. Propagation is effected by the alate stage and also by wind drifting, which means that the pest is able to cover great distances.

It is only the climatic conditions which can greatly influence the population. Very hot spells in Summer present a danger to the larval stages, in that the plant hosts are weakened and the relative humidity is reduced. Diseases and parasites are scarcely known. The enemies of the larch thrips are chiefly predators of aphids which also feed on thrips. Past experience has shown that chronic occurrences of the larch thrips are to be expected in the low-lying areas of the Atlantic climate zone.

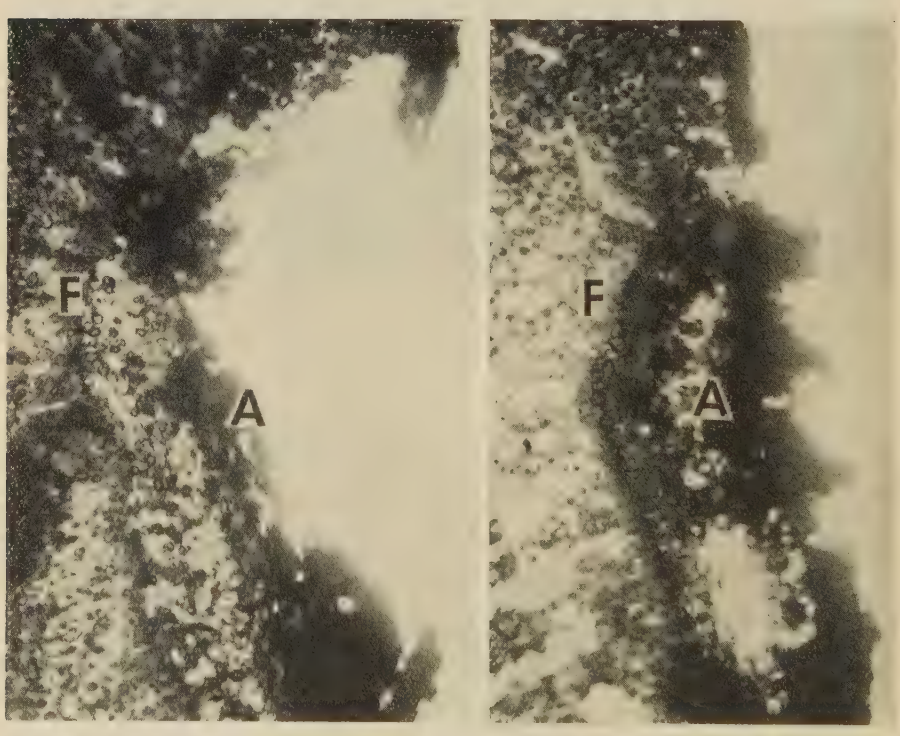


Fig. 4: Transverse shake formation on a seriously damaged shoot of the European larch, in longitudinal section (left) and in cross section (right). A = dead tissue section, F = wound-tissue (magnification × 50).

Fig. II: Leading shoot and secondary shoots killed as the result of damage inflicted by thrips; the greater part of the secondary shoots recovered after the thrips migrated from the larch, and formed new needle clusters towards the end of Summer.

Spatial and temporal basic principles for a control are indicated by the population ratios:

a) From August to April, the majority of the larch thrips population live in the Autumn and Winter quarters away from the larches, and in many cases even outside the larch stands.

b) A large increase in the population caused by insects drifting and flying onto the trees must be expected during the propagation stage of the thrips on the larch in May, June and July, in fact in the following phases: End of April/beginning of May resulting from general migration (1) from the Winter quarters to neighbouring larches, from the propagation (2) on the tops of other larches in May, the swarms of the Spring generation (3) in June and the Summer generation in July (4).

c) The greater part of the thrips population colonizes the needle clusters at the vegetation ends of the youngest long shoots, which means that they live in the newly grown periphery of the top sections. In cases of very serious infestation, the colonization may be extended to the long shoots in the lower crown sections.

These facts furnish an explanation as to why the chemical control of the larch thrips rarely proved to be a success, and then only when it was re-

peated. Since it is no rarity for the shoots of the young larches to grow half a centimetre every day in June and July, non-toxic zones appear in the periphery of the tree-top — which is preferred by the insects — only a few days after the application of the chemical, which thus permits a renewed colonization. This can originate from many sources: insects not affected by the pesticide, the egg and pupal stage, neighbouring populations.

Fig. 5: Damage caused by the larch thrips after 3 years: the former terminal shoot can still be perceived as a dead apex. The stem contortion is compensated for by eccentric growth.

The larch casebearer, which must also be categorized in the class of primary insects, has a wide ecological valence, and lives on both strong as well unproductive larches of all ages. An acute danger to the infested larches is only presented in exceptional cases when the locality favours chronic mass reproductions, and when at the same time the weather and the site factor inhibit the growth, and consequently the regeneration of the larches. The casebearer has for many years past occurred in Central Europe as a chronic pest which often shows a tendency to mass reproductions although there are a large number of parasites and enemies which regularly decimate its population. The distribution of the population in the stocks is very irregular.

and is governed by the preference the pest shows for places where there is plenty of sun and no wind. On the tree itself, the casebearer larvae live chiefly in the centre and lower parts of the crown. However, eggs are also laid to a large extent in the top parts of the tree, although in Autumn and Spring, particularly when there are mass occurrences, the larvae like to weave their way down to the lower branches resulting in a desertion of the tree-top and a dense colonization of the lower parts of the crown. The top parts of the tree remain more or less undamaged in Spring, and are therefore suitable for the next colonization of the larch casebearer.

Fig. 6: 14 year old European larches which tend to assume a thick bush-like appearance as the result of chronic damage inflicted by casebearers, accompanied by repeated fork formation. Type illustrating poor regeneration form; in Summer 1953 (left, front boughs removed), in Winter 1953/54 (centre), and the upper part of the cut-out right fork.

b) Assessment of the damage

The damage inflicted by the larch thrips is due to the extensive sucking activities of the population immediately below the vegetation point of the annual shoots, and therefore it occurs mainly when (beginning of July) the majority of the larvae of the second generation have emerged. Should the population of the first generation be very large at the time, which was the case in the Spring of 1954, there is every likelihood that earlier damage, although of an insignificant nature, will be caused (at the beginning of June). Those parts of the epidermis of the bark of the young shoots destroyed by sucking dry up, and as a result transverse shakes (Fig. 4) are formed which are shown up by early lignified zones. The accumulation of such damage can lead finally to an inhibition of the longitudinal growth of the shoots so that the tips die off. This occurs particularly when at the same time the growth of the larch is inhibited by a period of dry weather. Consequently, the weather, in addition to the population density, also exerts an influence on the extent of the damage. Moreover, typical needle curling (plus shoot deformation at

times) also occurs on the sucked parts, which is furthermore characterized by a heavy flow of resin. The secondary hosts of the thrips — Japanese larch, spruce and Sitka spruce — also reveal the same characteristic formation of transverse shakes in the epidermis of young shoots, although it is only the Japanese larch which may be adversely affected by this condition later on, and not the spruce. The very soft shoots of the Sitka spruce suffer more than the hard shoots of the spruce (Fig. 3).

In seriously damaged larch stands, a loss of one third of the annual height growth must be anticipated. The control tests described below furthermore showed, in comparison with neighbouring larches left untreated, that there was a considerable inhibition of the shoots and the needles in the entire top region of the tree, a condition which leads to an inhibition of the assimilation zone of the tree-top (Fig. 10). This in turn has an effect on the later growth. One can probably not speak so much of a physiological weakness — it would have led to the migration of the thrips which is very susceptible to turgor fluctuations — as of an unfavourable displacement of the assimilation zone.

The regeneration following the damage caused by the thrips varies greatly in its form and extent. Particularly in Spring, thick clusters of regeneration shoots begin to form around the dead leading shoot. If the leading shoot which dies in Summer, is replaced by a secondary shoot in the same year, regeneration forms ensue. Of course the form of regeneration varies greatly from case to case, and is of great importance with respect to overcoming the damage. There are certain larches which repeatedly show a tendency towards the formation of forks, and very soon assume a bush-like appearance (Fig. 6) while other larches are inclined towards a simple, favourable compensation for the leading shoot, and only form bayonet-shaped tops (Fig. 5). The stem forms of such larches are adjusted within a few years by eccentric diameter growth. This applies chiefly to slender-branched larches.

The continual loss of height growth due to damage inflicted by thrips can attain such proportions when the larches have reached an age where they are exposed to maximum danger (8 to 24), that it amounts to several metres. The result of this is that larches growing in mixed stands succumb to the competition of neighbouring trees. Several examples of this have been encountered in the past few years. Yet even in stands where the larch predominates, the influence of the damage caused by thrips can lead to considerable changes in the structure. The photographs of two European larches taken during the past three years give an example of this (Fig. 7). In 1952, the larch on the left, which became bushy as the result of the damage inflicted during the previous year, was by far inferior to the tree on the right, although in 1953, in contrast to the other one, it made a full recovery, and in 1954 it outgrew the right hand tree completely. In the meantime the terminal shoot of the tree on the right died off. The photographs also show the abnormal changes in the shape of the tree-tops as they occurred during the course of 1952, due to a heavy infestation of thrips and the influence of three weeks of dry weather in July. Both larches show a tendency, however, towards favourable regeneration forms, although the thrips infestation had led to considerable inhibition of their height growth.

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Fig. 7: Changes in the shape of the top of two European larches over a period of 3 years (details are given in the text).

20. VI. 52

31. VII. 52

15. X. 52

1952/53

6. X. 53

Even the extent of damage caused by the larch casebearer is — in addition to the population density — governed by the weather. It is, however, also largely dependent upon the locality. Dry spells during the feeding period of the larvae in Spring inhibit the growth of the needles, thus adding to the damage; analogously, the weaker growth of larches in a few localities leads to the same phenomenon. The opinions on damage caused by casebearers differ greatly nowadays. It is certain that even repeated cases of clean eating in vigorously growing stands are not so serious as to warrant a control, except of course in mixed stands where the larches are endangered. It is, however, also a definite fact that it is not possible to make up for the loss of assimilation surface (Vité 1954), and that such losses may represent a danger to weakly growing European and Japanese larches in certain localities.

### c) Possibilities for carrying out a control

#### Larch thrips

The most important question to be answered in connection with the control of the larch thrips is whether the main purpose of the control should be to reduce the local population or whether the control should be aimed at protecting endangered larches against acute damage. The consequences in the first instance are the spreading of the insecticidal treatment over large areas, the inclusion of such secondary hosts as spruces and Sitka spruces, and the repetition of the application of insecticide, in other words measures such as would appear expedient from the empirical experience gained in previous control tests.

The first application of insecticide is carried out five weeks after the emergence of the needles in an attempt to kill the females which have migrated to the larches, and after a further three weeks have elapsed a second application is carried out directed against females which have either survived the first treatment or which have flown onto the trees in the meantime, and also against the larval stages which have emerged from non-affected deposits of eggs. The second treatment is, therefore, carried out before the swarming of the Spring generation which hatches out approximately 10 weeks after needle burst, so that it would be necessary to carry out a third control in areas where a large-scale immigration of alate stages is expected. Therefore, in areas where there is mass development, it will not be possible to keep to the control dates mentioned here, which incidentally have been recommended by Ewald (1954), but rathermore the second treatment will have to be carried out at the end of June to the beginning of July at the earliest, as previously reported on the basis of past experience (Vité 1953).

Apart from the biological and economical inexpediency of the repeated control it is also extremely doubtful whether it will be successful. It is most difficult, and in fact for practical purposes impossible to study the distribution of the population from the aspect of space and time so as to produce data which would enable us to obtain a decimation of the local population, thus achieving the real purpose of the control. The hopelessness of being able to eliminate the widely spread pest in areas of mass development even when several controls are carried out should lead to limitations being placed upon the application of poison, which will be of some consequence. Since no damage is inflicted on the larches by the hibernated females, and moreover as the damage caused to the larches by the first generation at the beginning of July is very slight, no more thought need be given to it. This means that a single treatment (at the beginning of July in North-West Germany) would then be directed against the larval stages

of the second generation in order to prevent serious damage being inflicted. The disadvantage of this method is undoubtedly that slight damage is unavoidable, furthermore the success of the control is restricted temporally, and the treatments would have to be carried out at short notice. The economic advantages and the greater biological expediency of this method should, however, outweigh the disadvantages. In particular, this method enables forest officers to delay the control until the very last moment, and to gauge the scale of the application more precisely so as to cope with the situation actually encountered, because it must also be remembered that the weather, in addition to the population density, also determines the extent of the damage. The area to be treated can also be limited to a minimum since it is possible to establish the actual locality of the infestation from the symptoms of damage, in particular needle curling. The preparations best suited for application have been widely discussed. The usual types of contact insecticides have, however, differed very little so far in their effect against the larch thrips. Just the same, preference should be given to an "E 605"-Folidol preparation for treating larches at the beginning of July especially if the larch casebearer can be controlled at the same time since at this stage of the year the larch casebearers are to the greater part already living in the needles as egg larvae. Complete success cannot of course be expected from this method of control either against the larch thrips or against the casebearer. Past experience, however, has revealed that the effect will be sufficient to prevent serious damage.

Theoretically, the bionomy of the larch thrips indicates the possibility of concentrating the control on the spruce as the main Autumn and Winter host. Tests on this were prompted by the discovery that single intermixed spruces in larch stands, and spruces growing in certain localities — for example at the edge of the stand — were very densely colonized by overwintering females, so that by eliminating them a reduction of the population appeared feasible. The only hope of controlling the overwintering insects from the very outset, is in larch stands where the percentages of spruce growing in or around the larch stand are fairly low, which is seldom the case. The control would, in addition, have to be carried out during the most unfavourable part of the year (September to March), namely at a time when the insects hardly ever leave their hiding places. Consequently this possibility cannot be entertained for practical purposes.

## Larch casebearer

The control of the larch casebearer can be carried out at various times and with several preparations.

1. The poisoning of the young larvae, while they are boring in the needles, with systemic preparations during late Summer.
2. The control of the hibernating larvae.
3. The poisoning in early Spring of old larvae while they are wandering about the shoots in search of nutrition.
4. The control of the casebearer in the winged stage.

If it is just a matter of controlling the larch casebearer, then I am of the opinion that the Spring control should be given preference over controls at other times of the year, for several reasons. A better check can be kept on the emergence of the pests after they have overwintered and it permits a wider choice of the preparations to be used and the methods of application to be

employed, whereas with a late Summer control entomologists have to rely on a systemic insecticide. In the Winter control too, there is a limit to the preparations which can be used. Compared with the Winter control, applications made in Spring allow advantage to be taken of the movements of the caterpillars on the shoots while they are in search of food, which means that they easily come into contact with the insecticide. A further advantage of the Spring control, also

Fig. 8: Larches treated with insecticide by means of the binding method.

common to the Winter control, is that the insecticide, applied to the needle-less larches, in the main only poisons the casebearer caterpillars, and does not affect the useful and indifferent fauna. There is, however, one disadvantage in that very little time is available in which to prepare and carry out the control since the Spring treatment should be completed just before bud burst, or at the latest 10 days after bud burst. This means that there is only a period of two weeks in which to complete the treatment, while the late Summer control can be carried out at any time between the end of July and the middle of September, as the conditions permit (Thalenhorst, 1953).

In contrast to this, a control of casebearers during the flight period must be carried out at the beginning of this period, which is a disadvantage since it must be done very suddenly and early, and then it is inadequate due to the prolonged swarming of the casebearers lasting 4 to 5 weeks. Just the same, it appears that a control of the casebearer at the beginning of June would at the same time be effective against the larch thrips. A test carried out to verify this taught us, however, that the effect was not satisfactory either against the casebearer or against the thrips, while repeated applications during the vegetation period are not advised for the reasons given above.

### III. Control test with systemic preparations, employing the binding method

By comparing the bionomic data of both pests with the temporal and spatial possibilities for a single control, it is seen that in order to ensure any prospects of success, such a simultaneous control is only conceivable in June or at the beginning of July. It must be directed against the imagoes of the Spring generation and the larvae of the Summer generation if damage by thrips is to be avoided. Moreover its effect must be persistent enough to kill the egg larvae of the casebearers which emerge between the middle of June and the middle of July. Apart from the application at short notice — mentioned above — of a systemic preparation either in spray or dust form, with an effect limited both in its extent and its persistency, there is another method of carrying out a simultaneous control which was tested recently by Jancke (1954) in fruit growing. An absorbent material, soaked in a highly concentrated systemic insecticide, and protected against evaporation by a covering of impermeable material, is wound around the infested stems. The preparation diffuses through the bark, and is absorbed by the plant.

At first glance, this method appears to be most promising due to a number of advantages: Firstly it has a persistent action, effective particularly against the thrips because over a long space of time the newly growing vegetation parts, namely the feeding places of the thrips, are also rendered toxic. Another considerable advantage is that other boring and sucking insects are killed at the same time while the indifferent and useful fauna are not affected. Furthermore, the control can be carried out with simple preparations irrespective of the weather, and it can be limited to those trees deserving of treatment. In the larch stands, these are the well-crowned trees in an advance stage of growth, which on the other hand are colonized preferably by thrips, so that it would appear possible also to trap a large section of the population. The ability to switch the control to different points makes the method particularly suitable for mixed stands in which the control of both pest species is an urgent necessity. A corresponding test was carried out at the beginning of July in a 12 year old larch stand of the Forestry Training Office, Kattenbühl (Hann.-Münden). A layer of cellulose, the width of the hand, was wrapped around the larches (5·5 to 10·5 cm thick at chest height), and covered with a simple protective layer against evaporation. The cellulose was then soaked on the tree with an average of 250 ccs of solution, applied from a can (Fig. 8). The preparations used were 5 %, 2·5 % and 1 % "Metasystox" and 5 % "Systox", each applied to larches of different thicknesses.

"Systox" was used solely for the purpose of carrying out a comparative test, since previous tests with this preparation had shown it to be somewhat ineffective against larch pests. The considerably lower toxicity of "Metasystox" was an incentive to give preference to this preparation. The application was

Fig. 9: The larches treated with insecticide by means of the binding method show vigorous height growth in contrast to their non-treated neighbours (left).

carried out about 10 to 14 days too late so that slight damage had already been inflicted (perceptible in Fig. 9, centre of shoot).

An attempt had been made in October, 1953, employing the same process, to treat admixed spruces growing in a larch stand, which were more heavily colonized by overwintering females. The test proved unsuccessful.

The effect became noticeable in the tops of the 4 to 7 metre high larches after 8 to 10 days. Dependent upon the concentration and the date of egg laying, the egg larvae of the casebearers were killed immediately they started boring into the needles, or after they had made a short gallery. Long galleries were only made in the needles of larches treated with a 1 % concentration, and on which the effect varied. An o v i c i d a l effect was not established. The eggs of the larch thrips embedded in the needles developed, and later young larvae emerged which could be identified by their small size and whitish colour. The young larvae, however, soon died, and as a result the yellowish coloured, older juvenile larvae and the larvae of the second stage were missing completely. The long shoots of the larches treated with concentrations of 2·5 to 5 % remained free from damage by thrips until the end of the vegetation period (Figs. 9, 10), although by the beginning of September large numbers of imagoes had appeared

in the needle clusters which at that time had reached an advanced stage of development. It cannot be said, however, whether they were frightened away or killed. The top shoots of the neighbouring, untreated larches were mostly so seriously damaged that at the beginning of September only very few imagoes and larvae were to be found on them.

The situation at the beginning of September, two months after the test began, was as follows:

| Diameter at 1·3 m | Height | Preparation and concentration | Effect against | |
|---|---|---|---|---|
| | | | Thrips | Casebearers |
| 7—10 cm | 5·6 m | "Metasystox" 5% | pronounced effect, no damage (Fig. 10) | 100% kill |
| 5·5—9 cm | 4·2—6 m | 2·5% | good effect on strong stems (Fig. 9) | 100% kill |
| 7·5—10·5 cm | 4·5—7 m | 1% | no effect | varying effect |
| 7·5—10·5 cm | 5—7 m | "Systox" 5% | unclear effect | 100% kill |

The effect on other larch pests cannot be assessed at present; old larvae of the larch tortrix (*Laspeyresia zebeana* RTZ.) living in a gall were not affected.

The results revealed that the casebearer is extremely susceptible, and that the egg larvae of this species can be killed even by low concentrations. Furthermore, the strange fact came to light that among stems of equal age, those with a small diameter and correspondingly weak growth did not translocate the preparation so well as those with vigorous growth and a correspondingly large diameter.

In closing, I would broach the question as to what prospects exist with respect to the employment of this process in practice. Even though we are still not familiar with the most favourable technical means of application, it is obvious that this process incurs higher costs than the surface application of insecticides. However, the costs should not be overestimated. Assuming that approximately 400 larches per hectare are to be protected in a mixed stand, the expenditure will correspond somewhat to that incurred for two applications of "E 605"-Folidol. A repetition of the treatment in the following years could be carried out with smaller quantities of preparations. It is so imponderable to say what the ratio of the control success to the costs would be, that it would not be right to give a general verdict. In certain districts where the larches, often planted at high costs, are to be preserved as an admixed tree species, a control method which affords full protection against both pests is worth far more than in localities where the larches can easily be done without. Tnerefore,

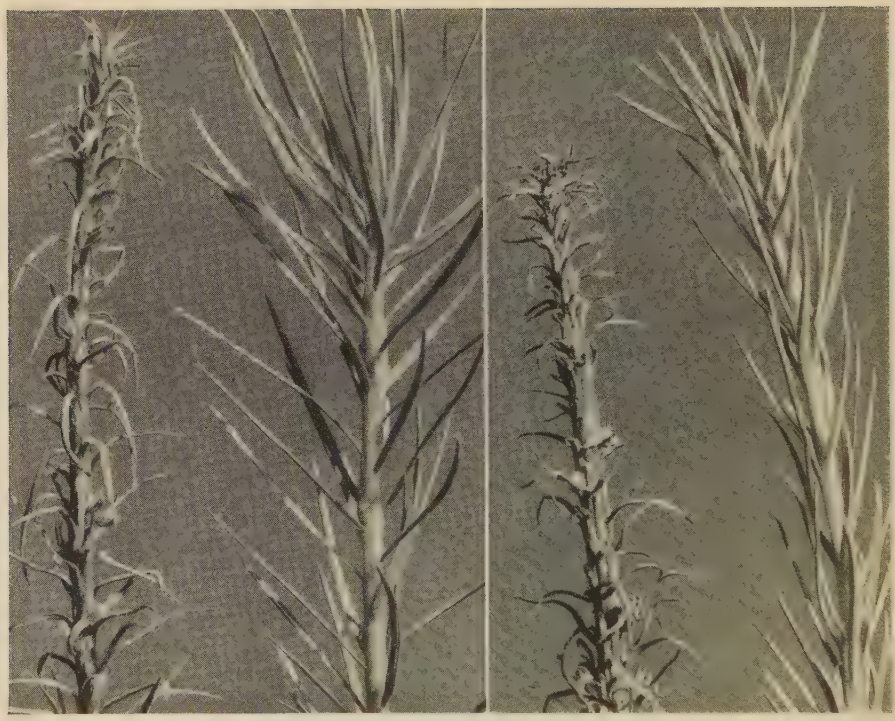

Fig. 10: Healthy top side shoots, showing strong shoot and needle development, on larches treated by means of the binding method (second from the left, and extreme right), in contrast to damaged top side shoots of untreated, neighbouring larches, which are degenerated and show poor needle development; September, 1954.

this method will be a great aid to forest officers particularly in those cases where it is a matter of helping valuable single stems or admixed tree species over a crisis.

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# The Occurrence of Wheat Earcockle in the Eifel

by Dr. A. Becker, Pest Control Office, Bonn

One of the rarest diseases occurring in cereals in this country is earcockle caused by the wheat nematode worm (*Anguina tritici* Steinb. or *Tylenchus tritici* Stein). P. Kotthof (4) believes that as the result of the introduction of new seed, seed dressing and crop rotation, earcockle has disappeared in areas where wheat is grown. Observations and inquiries carried out by the Pest Control Office, Bonn, between 1951—1953 revealed, however, that in the district of Blankenheim (Schleiden) there is still evidence of this disease which proves that even now it still occurs occasionally in Germany (2). This was confirmed verbally by L. Rump, Head of the Pest Control Office, Mainz, who pointed out that cockle is often found in the South Eifel, and that in many a year one would have no trouble in collecting large quantities of earcockle-infested grain at the community threshing places of that district.

A few years ago B. Rademacher (7) reported on other occurrences of earcockle. During the years following the war the infestation of earcockle in spelt fields in Württemberg — spelt is grown on a large scale in this particular province — was so great that even in one of the seed producing factories all the varieties of elite seeds were infested and had to be disinfected by means of

Fig. 1: Wheat ears infested with cockle

a special hot water steep process, since cockles cannot be removed from spelt simply by cleaning the seed well as is the case with wheat.

In 1944 St. Mastauskis, Dotnuva (5) reported on occurrences of the wheat nematode worm in Lithuania. Prior to 1930 the wheat nematode had never been encountered in Lithuania, this also applying to Latvia and Estonia. Later, however, this pest made its appearance in many districts, where there are predominantly small farms, to such a great extent that in one field in particular 60 % of the ears were found to be infested with earcockle. In Lithuania only spring wheat was infested, and in fact the susceptibility of the different spring wheat varieties varied. To control the wheat nematode an order was

Fig. 2: Cockle in wheat

issued in the infested areas of Lithuania prohibiting the growth of spring wheat since investigations had shown that under the conditions prevailing in that country the wheat nematode is not able to hibernate outdoors. In contrast to the observations made in Lithuania, it was found that in the Eifel the wheat nematode only occurs on winter wheat, and that in Württemberg it is the spelt sown in autumn which is infested. This leads to the question as to whether there are several frost-resistant and frost-sensitive species among the wheat nematodes, since the majority of winters in the Eifel and in many parts of Württemberg are far from being mild.

As a result of infestation by wheat nematodes, the so-called cockles (Figs 1 and 2) are formed in place of healthy grains. On wheat these are small, hard, round and blackish-brown coloured galls, which may be easily mistaken for masses of stinking smut. They also resemble the seeds of corn-cockle, hence the name earcockle. The nematode galls on spelt are mostly narrow and long with a well-defined tip at the apical end (7).

In contrast to the stinking smut masses, cockles are hard and when cut open a whitish mass is found in the interior. According to Goffart (3), each gall contains 1—6 females and 2—7 males of the wheat nematode (Fig. 3). Since each female develops 2000 to 2500 eggs, in many cases one gall can con-

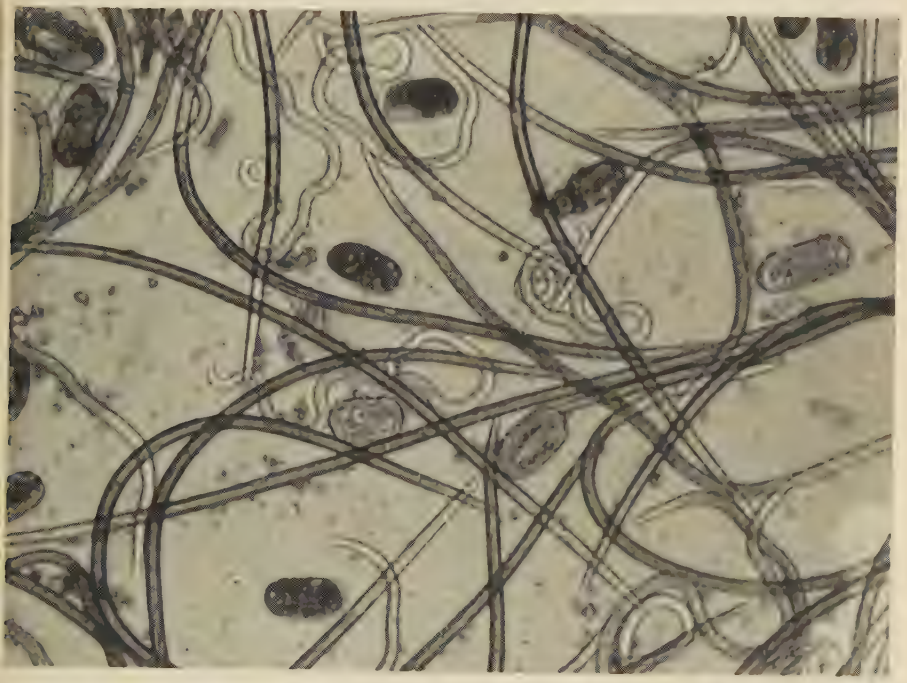

Fig. 3: Photo-micrograph of wheat nematodes in cockle

tain 8000—17 000 larvae. The investigations carried out in Lithuania (5) revealed that while they are in the gall the larvae are able to remain in the dormant stage for anything up to 9 years.

It is when the cereals are sown that the cockles find their way into the soil where they are softened by the moisture contained in the soil. The larvae migrate from the galls and attack the young wheat plants. Goffart (3) writes that in Germany infestations occur mostly in May, although Rademacher (7) observed an infestation as early as March/April. This agrees with my own observations during sowing carried out on the test fields of the Pest Control Office at Bonn.

The larvae are first found in the leaf axils. As the plant host develops, the larvae move off and penetrate into the flower where once again galls are formed. In July, at a time when the healthy grains have already assumed a yellow colour, the cockles are a dirty green. The infested ears can mostly be recognized from their spread-out appearance, just as with stinking smut of wheat.

Very soon after the infestation begins, the plants show themselves to be infested by leaf curling and twisting. Despite the fact that they have started to attack the plants, there is always the possibility that the nematodes will not penetrate into the flowers, and it is even possible to find cockles and normal wheat grains occurring in one ear. The development of the nematodes and the formation of cockles depend greatly upon the weather. Apparently infestations are furthered in years when there is plenty of rainfall and the weather is generally damp, whereas in dry years infestation is inhibited. It is also probable that the type of soil has very much to do with the occurrence of wheat nematodes. In 1951 there was a very heavy infestation of earcockle in the district of Blankenheim, where the soil contains lime. In 1952 on the other hand, there were no earcockle-infested ears to be found anywhere in the area even though a very thorough search was made. It is probable that a change of seed and the issuing of instructions to local farmers contributed to the disappearance of the wheat nematode in Hüngersdorf, the place which suffered most from the infestation, although this was not the case in the neighbouring villages where to a certain extent there were serious outbreaks of earcockle in 1951. In 1952 only one field was found infested with earcockle, the reason for this being that the farmer had sown seed which he had produced himself and which had not been cleaned. Needless to say all the other fields were healthy.

Quite often twist, which is caused by the fungus *Dilophospora alopecuri* or *Dilophospora graminis* Desm., may be found occurring together with earcockle. Mostly it is wheat and spelt (7) which are infested by this disease although rye and wild grasses (Fig. 4) are also affected. Formerly twist was to be found more in France and Switzerland, although according to information from Dr. Z o g g , Zürich-Örlikon, this disease no longer occurs in Switzerland. Following the first world war twist was wide-spread in Western Germany and to a certain extent inflicted considerable damage. Seed change and seed cleaning, however, soon led to its disappearance. From 1945 onwards it reoccurred again in Württemberg (7), and in 1951 the Pest Control Office at Bonn received reports of a large-scale infestation at Blankenheim/Eifel (2). At the village of Hüngersdorf, located in the Blankenheim district, several fields were so heavily infested that there were yield losses amounting to 30—50 %. In 1951 cockle was also found in all the wheat fields infested by twist. Again in 1952 another case was discovered of twist and cockle occurring together in one field.

Several investigations were carried out with the object of clarifying the interrelations between earcockle and twist. On the strength of the work he had carried out, A t a n a s o f f (1) considers himself justified in assuming that *Tylenchus tritici* plays a vital part in the infection process itself. In the words of S c h a f f n i t and W i e b e n (8) he envisages this process as follows:

"... The spores which have appendages easily remain attached to the nematodes. This was illustrated by an experiment in which nematodes were placed in a spore suspension. A t a n a s o f f assumes that the nematodes transport the fungus in this manner as far as the vegetation tip, not thinking of the simple method of spreading but believing that the nematodes play an important part in the infection insofar as they damage the plant thus enabling the fungus to penetrate into the living tissue. On the other hand

Fig. 4: Twist in wheat, rye and silky bent (Photo: Renate Braun)

Atanasoff assumes that the fungus is not able on its own to maintain the connection with the vegetation tip of the plant host, but that a new infection must constantly take place with the aid of *Tylenchus*."

Schaffnit and Wieben (8), in their investigations, were, however, successful in bringing off an artificial infection of *Dilophospora graminis* on rye and wheat seedlings without the aid of *Tylenchus tritici*. Atanasoff's hypothesis cannot therefore be regarded as being absolutely applicable in all instances. The fact is, however, that in wheat and spelt fields, twist and wheat nematode worms occur simultaneously in practically every case. Recently Mühle (6) reported that in Central Germany twist occurs on grasses together with another nematode species. This species was found by Goffart to be the leaf nematode *Ditylenchus graminophilus* Good.

In view of the observations that have been made, it cannot be disputed that there is a certain connection between the occurrence of twist and the nematode infestation, and it would not be right to attribute this joint occurrence solely to the old-fashioned methods employed on the small farms where the two diseases chiefly occur.

Even though at present no great economic significance is attached to earcockle and twist, it would, however, be most advisable to keep a close watch on both diseases in future particularly when it is considered that they can cause considerable damage should protective measures be neglected.

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## Supplement to the paper by Dr. M. Hanf "The present extent of plant protection measures", published in "Höfchen Briefe" No. 1, 1953

In the No. 1 edition of "Höchfen-Briefe", 1953, on Page 4, Dr. M. Hanf writes in his interesting article on "The present extent of plant protection measures": "The sole aim of the district offices for plant protection, first opened in Hesse and Pomerania in 1937, was to put into practice on the broadest possible basis all knowledge gained in research work". Dr. Ext points out that a branch office of the Department for Pest Control and Plant Protection, Kiel, was opened as early as the end of 1953 in Schleswig-Holstein, with the sole aim of applying on the widest possible basis the knowledge gained in research to practical pest control and plant protection work. After surmounting numerous difficulties, this office, from which the present Branch Office for Pest Control and Plant Protection at Rellingen originated, operates with extreme success as an indispensable counsellor to the practice, and in preparing the way for pest control in the extensive tree-nursery district of Holstein.

Dr. Ext was given very much guidance by the ideas of his tutors, Prof. Escherich and Prof. Appel, in preparing the way for the establishment of this branch office, and in fighting the hard battles to finance it. Prof. Appel never ceased to highly praise and promote the work of this first branch office for entomology and plant protection. Today the practice realises how much it is indebted to this branch office, and also to Landw.-Rat Dr. Hermann Fischer, its head for many years. The vast experience gained at Rellingen led in the years following to the establishment of other branch offices, and in this the thought continuously to the fore was to maintain direct contact with field workers in order to become familiar with their trials and tribulations, and to assist them by giving personal advice and practical assistance on the spot. The five branch offices which were set up in Schleswig-Holstein some years ago, partly as the result of pressure and with meritorious international financial aid, are today with their district technicians, indispensable links between the official extension service (Department of Entomology and Plant Protection) and workers in the field.

Dr. Ext (Kiel)

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